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Equity Research
Asia Pacific | Taiwan

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Asia Semiconductor Sector

Taiwan IC design service: Advancing with China CPU substitution and AI acceleration

Semiconductor Devices | Initiation

Figure 1: Taiwan IC design service valuation table

Company	Ticker	Local Price 7/17/2020	Mkt Cap (US$mn)	Ent. Value (US$mn)	Range	P/E Multiple 2020	P/E Multiple 2021	EV/EBITDA 2020	EV/EBITDA 2021	EV/Sales 2020	EV/Sales 2021	P/B Multiple 2020	P/B Multiple 2021	ROE 2020	ROE 2021
IC design service															
Global Unichip	3443.TW	$284.00	$1,291	$1,173	156.0-323.5	70.9	33.0	32.1	19.0	2.8	2.3	8.7	7.4	12.3	22.5
Alchip	3661.TW	$480.00	$999	$888	93.0-575.0	31.0	22.9	11.5	9.4	4.0	3.0	7.2	6.0	23.3	26.1
Faraday	3035.TW	$48.95	$412	$412	29.2-63.5	29.7	23.6	NM	NM	NM	NM	2.3	2.2	7.7	9.3
IC design service Median:						**31.0**	**23.6**	**21.8**	**14.2**	**3.4**	**2.7**	**7.2**	**6.0**	**12.3**	**22.5**
IC design service Mean:						**43.9**	**26.5**	**21.8**	**14.2**	**3.4**	**2.7**	**6.1**	**5.2**	**14.4**	**19.3**

Source: Company data, Credit Suisse estimates

- **Growth by connecting foundries with start-ups/system companies.** IC (Integrated Circuit) design service companies are leveraging semiconductor design capabilities and tight foundry relationships to supply system companies and emerging fabless design companies with design support, bringing to market increasingly challenging and customised designs for high performance computing (HPC). The Taiwan design services companies accelerated from flat during the 2007-13 period to a +9% CAGR from 2013-19, and could further accelerate to 20% growth from a fast growing pipeline of HPC (AI, 5G, server, PC, and networking).
- **China's CPU localisation accelerates.** Design service companies are well placed to fulfill Chinese policy goals aimed at technology self-sufficiency and leadership as a bridge between emerging companies and the advanced foundries such as TSMC, and, to a lesser extent, SMIC. We believe the PC/NB CPU used in the government applications and SOE is the first wave of applications and server CPU should follow, with Phytium, an ARM CPU fabless, leading its local peers on the strong technology roadmap, ARM's ecosystem support and better technology control. We believe Alchip, Phytium's back-end design partner, could benefit from a growing local CPU demand with long-term potential from the Chinese government and SOE at US$720 mn (vs its sales at US$144 mn in 2019). Alchip also has exposure to China's supercomputing system, with its SAM per system growing to US$50 mn on 7nm.
- **Growing AI computing drives ASIC demand.** Design service is seeing another HPC opportunity in customised ASICs, with very high third-party growth expectations (from US$12.3 bn in 2019 to US$43.9 bn in 2024E), by providing more efficient computing for training, inference, and supercomputing. AI acceleration is broadening from CPU, GPU and FPGA from established chip companies to a diversified ASIC customer base supported by design service companies, with migration from 16/12nm to next-gen 7nm projects.
- **Initiate coverage on Alchip and Global Unichip.** We initiate coverage on Alchip with an OUTPERFORM rating and a TP of NT$630.00 (31% upside), based on 30x our 2021E EPS. The upper half of the valuation of 10-30x P/E should be supported by the opportunity in China's PC CPU replacement demand and leverage in multiple AI projects. We initiate coverage on Global Unichip with a NEUTRAL rating with a TP of NT$250.00, based on 28x our 2021E EPS, as we believe its share is fairly valued at the upper half of its 15-35x range, factoring in its opportunity in 5G and AI but still has a 30% exposure to mature consumer and 10% to solar, which moderates growth. Key risks: (1) Slower local CPU/AI penetration in China or the US restrictions, (2) Consolidation or failure of emerging AI start-ups and system company projects, (3) Customers growth and shift to a foundry direct business model, (4) and intensifying competition from Verisilicon in China or build-up of more in-house teams.

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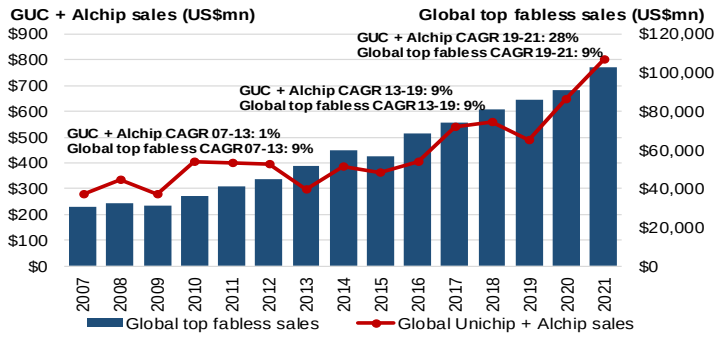
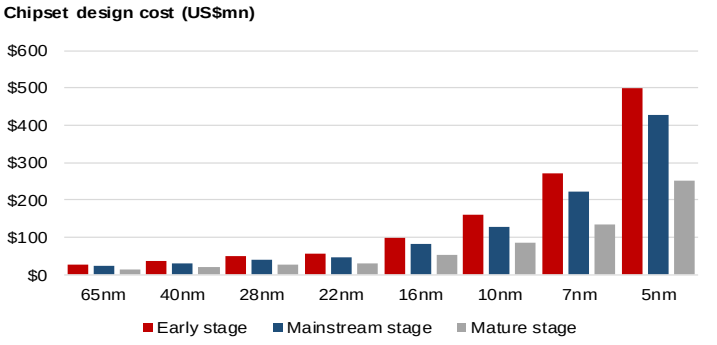
Focus charts and table

Figure 2: Taiwan IC design service business accelerates



Source: Company data, Credit Suisse estimates

Figure 3: IC design cost surges in the advanced nodes



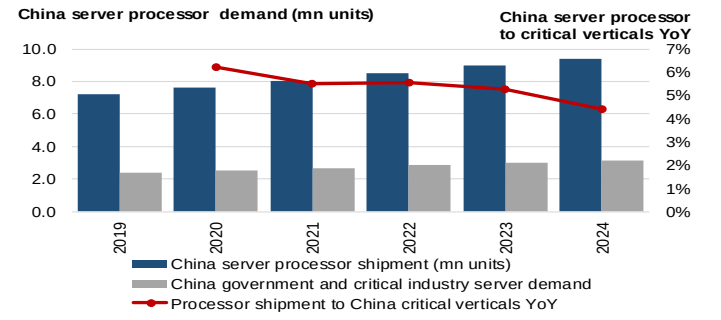
Source: Synopsys

Figure 4: Comparison for the development for the major China CPU fabless

China CPU fabless	Loongson	Phytium	Kunpeng	Sunway	Hygon	Zhaoxin
Shareholders	Institute of Computing Technology, Chinese Academy of Sciences	China Great Wall, CEC Group	Huawei	Wuxi Jiangnan Institute of Computing Technology	Sugon, AMD, Hygon	Shanghai Zhaoxin (VIA + Shanghai government)
Architecture	MIPS32	ARM v8	ARM v8	Sunway 64	x86	x86
PC	3A3000	FT2000/4	920s	SW410	7185	KX-6000
Tech spec	1.5GHz Quad core 64 bit	2.0GHz Quad core 64 bit	2.0GHz Quad / Octa 64 bit	1.6GHz Quad core 64 bit	2.0GHz 32 cores 64 bit	2.0GHz Quad core 64 bit
Manufacturing node	28nm	16nm	7nm	40nm	14nm	16nm
Server	3B3000	FT-2500/64	920	SW26010	7185	KH-30000
Spec	1.5GHz Quad core 64 bit	2.5GHz 64 cores 64 bit	2.5GHz 64 cores 64 bit	1.45GHz 260 cores 64 bit	2.0GHz 32 cores 64 bit	3.0GHz Octa cores 64 bit
Manufacturing node	28nm	16nm	7nm	28nm	14nm	16nm
IC design partner	NA	Alchip, EE2	HiSilicon	NA	AMD	VIA
Ecosystem support	Limited	Strong	Strong	Limited	Strong	Strong
Security	High	High	High	High	High	High
China technology control	High	Medium-High	Medium-High	High	Low	Low

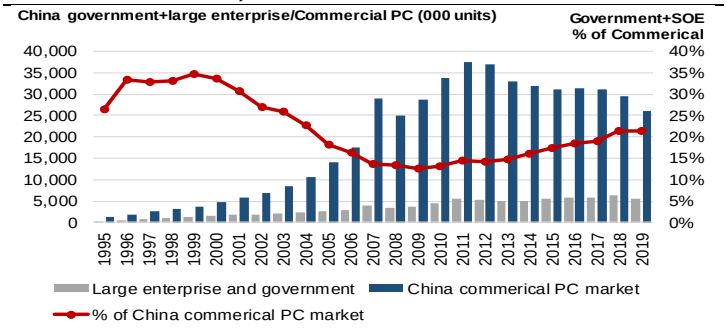
Source: Company data, Credit Suisse estimates

Figure 5: China's government and SOE server demand should be the 2nd wave application China CPU fabless penetration



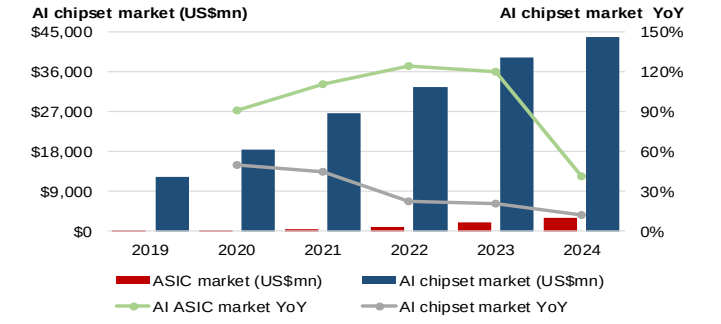
Source: IDC, Credit Suisse estimates

Figure 6: China government and SOE PC shipment at 6 mn units annual run rate, 20% of domestic commercial PC market



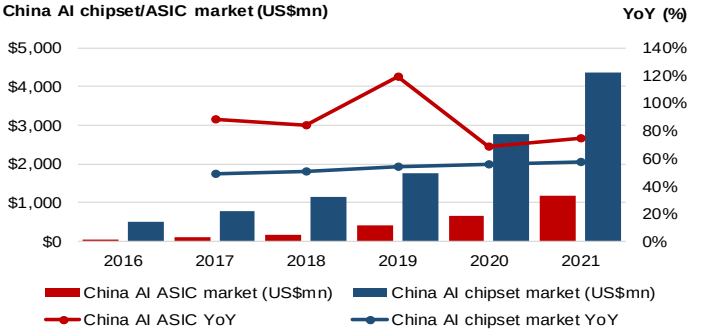
Source: IDC, Credit Suisse estimates

Figure 7: ASIC is going to outgrow AI semiconductor market



Source: Gartner, Credit Suisse estimates

Figure 8: China AI chipset demand is also seeing fast growth



Source: CCID, Credit Suisse estimates

Taiwan IC design service: Advancing with China CPU substitution and AI acceleration

We believe IC design service growth will accelerate as more system companies and start-ups develop customised chipsets, and form their position to aid China's semiconductor development as a bridge to design products with the foundries. The growing AI and HPC computing demand for customised chipsets lifts IC design service companies' addressable market. We initiate coverage on Alchip with an OUTPERFORM rating and a TP of NT$630, while we initiate coverage on Global Unichip with a NEUTRAL rating and a TP of NT$250.00.

The growing AI and HPC computing demand for customised chipsets lifts IC design service companies' addressable market.

A growing business connecting advanced foundries with start-ups/system companies

IC design service companies are benefiting from the trend of rising IC design difficulty as technology migrates, with design cost surging from US$26 mn on 28nm to US$52 mn on 16nm and US$130 mn on 7nm. To ensure successful tape-out and secure foundries' capacity, design service companies could fill the gap, supplying design support and foundry design-in to system companies and start-ups designing chipsets on the advanced nodes. The trend of IC customisation and higher design cost has accelerated the growth for major Taiwan IC design service companies at a 9% CAGR from 2013-19, in line with global fabless, following the slow period during 2007-13 (1% CAGR vs global fabless' 9%), when the market was dominated by the standardised chipsets (e.g., main processors in PC and smartphone).

We believe Taiwan IC design service growth will accelerate from 1% CAGR from 2007-13 to 20% from 2019-22E as more system companies and start-ups develop customised chipsets.

Design service leveraged to China's CPU localisation

Design service companies could support China's more aggressive stance in recent years to develop its own processors to capture more value in the tech chain and have better control of the IT ecosystem amid its ambition of 'Made in China 2025' and the growing trade tension with the US. We believe the PC/NB CPU used in the government applications and SOE is the first wave of chipsets China aims to replace (5 mn unit demand annually), and higher-end server CPU should be next (3 mn unit annual demand). We expect Phytium, a China ARM CPU fabless, to lead its local peers on the robust roadmap, migrating to 16nm for PC/NB and 7nm for server, benefiting its design service partner, Alchip supplying a US$720 mn TAM (vs its US$144 mn sales in 2019). Alchip also has exposure to China's supercomputing system which should see content per system growing from US$30 mn on 16nm to US$50 mn on 7nm.

Design service companies could support China's more aggressive stance in recent years to develop its own processors to capture more value in the tech chain and have better control of the IT ecosystem

Growing AI computing drives ASIC demand

Design service companies are also seeing new growth from AI chipset innovation accelerating to support demand for higher compute performance and data analytics required advanced semiconductor manufacturing technology. Gartner expects global AI semiconductor revenue to grow from US$12.3 bn in 2019 to US$43.9 bn in 2024E, at a CAGR of 29%. Although GPU and FPGA are the mainstream chipsets for AI computing, the demand for customised ASIC is rising as it can provide more efficient computing for training and inference, with AI chipset projects mostly on 16/12nm and 7nm, and driving growth for Alchip/GUC in the coming years.

Design service companies are also seeing new growth from AI chipset innovation accelerating to support demand for higher compute performance and data analytics

Initiate coverage on Alchip and Global Unichip

We initiate coverage on Alchip with an OUTPERFORM rating and a TP of NT$630.00, implying 31% upside, based on 30x our 2021E EPS, factoring in our expectation of 30% sales CAGR from 2019-22E. We believe the upper half of the long-term valuation should be supported by the opportunity in China PC CPU replacement demand, in addition to its AI exposure. We also initiate coverage on Global Unichip with a NEUTRAL rating and a TP of NT$250.00, reflecting 28x our 2021E EPS. We believe the company's share is fairly valued at the upper half of its range, factoring in its opportunity in 5G and AI. Key risks: (1) Slower local CPU/AI penetration in China or the US restrictions, (2) Consolidation or failure of the emerging AI start-ups and system company projects, (3) the US further expands its ban on China companies' access to IP/EDA tools, (4) Customers growth and shift to a foundry direct business model, and (5) and intensifying competition from Verisilicon in China or build-up of more in-house teams.

We initiate coverage on Alchip with OUTPERFORM and Global Unichip with NEUTRAL

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Valuation

Figure 9: Taiwan IC design service valuation vs their global fabless peers

Company	Ticker	Local Price 7/17/2020	Mkt Cap (US$mn)	Ent. Value (US$mn)	Range	P/E Multiple 2020	P/E Multiple 2021	EV/EBITDA 2020	EV/EBITDA 2021	EV/Sales 2020	EV/Sales 2021	P/B Multiple 2020	P/B Multiple 2021	ROE 2020	ROE 2021
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Taiwan Fabless															
Mediatek	2454.TW	$607.00	$32,717	$26,969	274.0-661.0	30.0	20.4	18.3	12.1	2.7	2.1	3.1	2.8	10.3	14.0
Novatek	3034.TW	$262.00	$5,408	$4,649	152.0-285.5	17.3	16.2	12.2	11.1	2.0	1.9	4.4	4.2	25.7	25.7
Realtek	2379.TW	$342.50	$5,934	$4,906	162.0-367.5	23.6	19.2	16.9	13.6	2.2	1.9	5.9	5.3	25.0	27.4
Egis	6462.TWO	$196.50	$476	$386	121.5-314.0	14.1	12.2	8.6	7.2	1.6	1.3	4.5	4.0	31.5	32.7
Elan	2458.TW	$139.50	$1,438	$1,255	70.0-144.0	17.4	16.7	11.4	11.8	3.2	3.2	5.2	5.0	30.0	30.3
Global Unichip	3443.TW	$284.00	$1,291	$1,173	156.0-323.5	70.9	33.0	32.1	19.0	2.8	2.3	8.7	7.4	12.3	22.5
Himax	HIMX	$3.81	$656	$765	1.8-5.1	47.6	19.5	20.1	11.6	1.0	0.8	1.5	1.4	3.1	7.1
Parade	4966.TWO	$1,075.00	$2,918	$2,554	513.0-1135.0	29.3	24.0	22.6	18.3	5.8	5.0	6.6	5.7	22.6	23.6
Silergy	6415.TW	$1,735.00	$5,426	$5,426	594.0-2015.0	49.2	38.3	45.6	35.1	11.9	9.6	9.1	7.7	19.6	21.9
Taiwan Fabless Median:						**29.3**	**19.5**	**18.3**	**12.1**	**2.7**	**2.1**	**5.2**	**5.0**	**25.0**	**25.7**
Taiwan Fabless Mean:						**29.9**	**21.9**	**20.5**	**16.0**	**4.8**	**4.1**	**6.2**	**5.5**	**22.7**	**25.5**
China Fabless															
Goodix	603160.SS	$215.56	$14,068	$13,328	142.6-373.3	58.1	57.1	54.8	51.2	12.2	11.6	13.1	10.6	22.6	18.6
Will Semi	603501.SS	$208.16	$25,689	#VALUE!	60.3-249.7	64.9	39.5	38.0	25.5	8.9	6.4	15.2	10.5	23.4	26.7
Wingtech	600745.SS	$130.00	$20,882	$22,909	34.8-166.3	49.5	34.7	26.7	21.0	2.4	1.8	6.1	5.2	15.3	16.8
Montage	688008.SS	$96.85	$15,637	$14,585	58.3-117.6	92.8	69.3	95.3	65.8	45.2	33.7	13.5	11.7	15.2	17.6
Gigadevice	603986.SS	$243.00	$16,348	$16,080	61.6-304.4	102.1	98.4	89.6	81.7	22.5	18.4	11.0	9.9	10.4	10.1
Maxscend	300782.SZ	$465.30	$11,969	$11,829	114.5-521.9	102.0	73.0	87.0	60.6	34.6	24.8	34.9	25.0	34.8	36.2
SG Micro	300661.SZ	$335.17	$7,445	$7,323	63.0-390.8	205.4	138.5	192.9	127.4	48.0	33.4	39.4	31.7	20.7	23.7
NavInfo	002405.SZ	$18.50	$5,186	$4,981	13.3-21.4	106.9	70.3	66.5	50.3	13.8	10.9	4.5	4.2	4.7	5.8
China Fabless Median:						**97.4**	**69.8**	**76.8**	**55.9**	**18.2**	**15.0**	**13.3**	**10.6**	**18.0**	**18.1**
China Fabless Mean:						**97.7**	**72.6**	**81.3**	**60.4**	**23.5**	**17.6**	**17.2**	**13.6**	**18.4**	**19.4**

Note: Priced as of July-17; Source: Company data, Credit Suisse estimates, Bloomberg consensus

A growing business connecting advanced foundries with start-ups/system companies

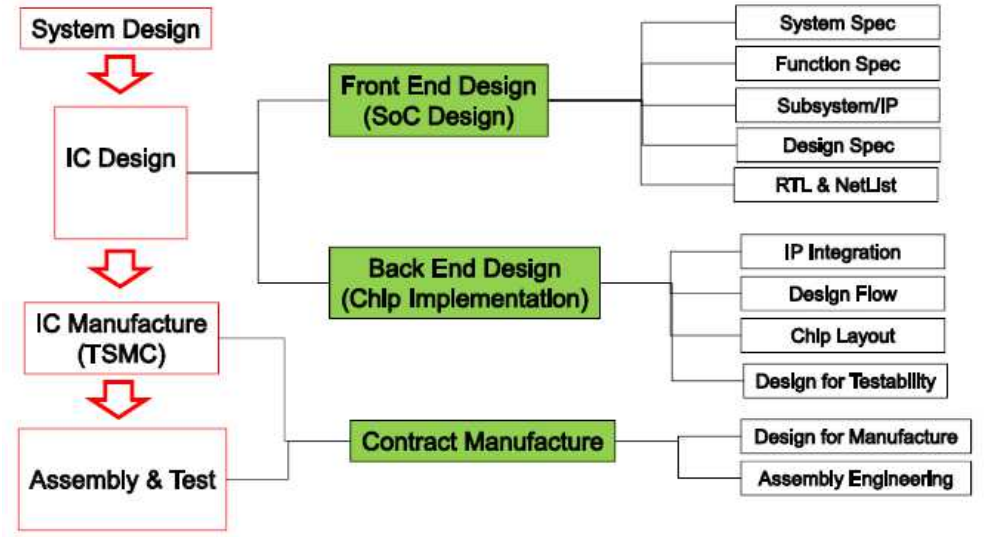
Semiconductor design plays a key role to drive silicon innovation and differentiation along with the manufacturing technology, delivering better performance, less power consumption, and at the same time, keeping the form factor small. The IC design process can be segmented into front-end design and back-end design.

For an IC design house or IDMs (integrated device manufacturer), they complete the whole process themselves, as they understand their customers' demand and have the technological capability to build an off-the-shelf chipset with their IC design engineering team.

The emergence of dedicated IC Design Service companies like Alchip, GUC, and Faraday fulfills the need for IC design outsourcing to save labour cost, speedy time-to-market of complex chip designs, leverage third-party expertise for certain technologies (e.g., IP, EDA tool), and also benefits the companies with a long track record of working with the foundries to ensure a fast ramp to mature yields. Factors supporting the growth include: (1) technology process migration to advanced nodes, which is making the difficulty of chipset design more challenging and costly, (2) rise of system companies' development efforts, they have less IC design capability in-house and require more customisation to meet certain requirements and usage (e.g., data centre, high-end consumer, and niche applications), and (3) both start-up and system companies incur high costs to keep a large IC design team and operations team to interface with foundry and back-end for their small number of projects.

To facilitate the chipset design, more and more companies are working with IC design service companies who have a dedicated team working with their customers on the complicated chipset design and allowing their customers to access the most advanced manufacturing technology at a lower cost. The IC design companies now can also add more value to their customers, including supply chain management across front-end manufacturing (foundry, back-end (packaging and testing) and delivery in addition to chipset design. The IC design service companies with a long-term track record and high tape-out success rate can support their customers' goal time to market, better cost structure, and at the same time ensure high level of customisation and good power and performance.

Figure 10: IC design includes front-end and back-end design before tape-out



Source: Global Unichip, Credit Suisse

In a typical IC design case initiated by the system companies, the concept of a product is decided by the system houses in the front-end design process, including the chipset function and performance requirement. After the function and the spec are defined, the target database

containing all the relevant details is also established (net list), and the electronic circuits are converted into logic gates for verification through the use of synthesis software.

The completed structure in the front-end design is provided to the IC design service companies for back-end design, including physical layout and verification and power/signal analysis, before they request their foundry partners' support for tape-out.

The back-end design can be divided into two phases. The first phase usually takes 6-8 weeks, starting from the initialisation of the design case through the receipt of customer's final net list. The second phase in which engineers use physical design software to convert net list to the actual layout, and generate the file named 'GDSII' for tape out, this process can take about 4-6 weeks.

With most of their customers' lack of scale and secure foundry capacity or lack of the experience in semiconductor manufacturing, the IC design service companies provide the turnkey solutions to their customers for chipset production, assembly, and testing, in addition to the front-end and back-end design. The period from delivery of GDSII to the completion of chip production cycle (front-end manufacturing and back-end packaging and testing) takes about 8 to 12 weeks.

Revenue stream for IC design service companies

For the IC design service companies, the revenue stream is usually from non-recurring engineering (NRE), production service (turnkey), and IP licensing and royalty revenue:

1. **NRE revenue (Non-Recurring Engineering):** The customised chipset design provided by the IC design service provide is called NRE, it can be divided into front-end design (design specification and logic verification) and back-end design (physical synthesis, place & route and physical verification). IC design service companies pass four milestones in their NRE revenue recognition process: (1) IP delivery, (2) final net-list-in, (3) tape-out, and (4) delivery of the engineering sample. Based on the project size and difficulty, IC design service companies can recognize US$1 mn+ revenue for a milestone of the NRE projects on 16nm and 7nm. For profitability, the NRE gross margins are usually between 30-50%, depending on the type, difficulty, and manufacturing technology of the project.
2. **Production service (turnkey):** After the chip design, the IC design service companies can provide one-stop shopping solution on foundry production, back-end assembly, and testing and inventory management, and logistics, in addition to the chipset design. The IC design service companies usually charge 10-20% over the total cost incurred during the production and shipment, earning a GM of 10-20% for that service. The margins are usually lowest among the IC design service business due to costly mask cost and wafer manufacturing, and packaging cost incurred in the process.
3. **IP licensing and royalty fees:** IC design service companies can provide their in-house silicon IP to their customers and standard cell library for foundries to receive the licensing revenue. Upon the use of the IP or the standard cell library in a project by its customers, the IC design service companies can charge the royalty based on the agreement. The business is usually close to GM of 100%.

Market opportunity for IC design service industry

The semiconductor IC design industry has seen healthy growth in the past decade at a 5-6% CAGR, mainly supported by the growing smartphone penetration and continued content increase and spec upgrade in the mobile devices from 2010-15. Started from 2016, the strength was led by the demand surge in high-performance computing, including data centre, cryptocurrency, and AI, boosting the demand for graphic and CPU, in addition to the modest growth in the smartphone semiconductor market.

Figure 11: China fabless should outgrow the industry in diversified applications, supported by the government policy

China IC Design Companies	2010 revenue	2011 revenue	2012 revenue	2013 revenue	2014 revenue	2015 revenue	2016 revenue	2017 revenue	2018 revenue	CAGR 2010-18	Major products
Shenzhen HiSilicon Technologies	$652	$1,032	$1,178	$2,120	$2,950	$3,299	$3,881	$4,480	$6,035	25%	Networking/Set-tops
Bitmain	$0	$0	$0	$0	$0	$137	$278	$2,518	$4,268	NM	Cryptocurrency mining machine
Spreadtrum Communications	$346	$674	$725	$1,050	$1,110	$1,640	$1,866	$1,587	$1,286	23%	Mobile processors
RDA Microelectronics	$191	$289	$391	$380	$339	In SPRD	In SPRD	In SPRD	In SPRD	NM	Connectivity and RF
Goodix	NA	$13	$86	$102	$127	$167	$448	$545	$522	NM	Fingerprint ICs
ZTE Microelectronics	NA	NA	$25	$45	$470	$520	$600	$775	$520	NM	Networking / Wireless
CEC Huada Electronic Design	$74	$128	$123	$169	$183	$504	$507	$368	$463	27%	Smart card ICs
Hangzhou Silan Microelectronics	NA	$238	$203	$263	$263	$300	$343	$402	$425	NM	Communications ASICs
BYD Microelectronics	NA	$144	$125	$105	$275	$345	$424	$403	$383	NM	Image Sensor / fingerprint
Galaxycore	$124	$190	$201	$295	$367	$350	$385	$365	$380	15%	Image Sensors
Beijing Nari Smartchip Microelectronics	$180	$220	$280	$350	$400	$436	$480	$408	$347	13%	Industrial ICs
Vimicro	$91	$64	$76	$65	$100	$276	$302	$293	$346	16%	Consumer ICs
Tongfang Guoxin	NA	$97	$90	$142	$180	$187	$198	$247	$330	NM	Smart card / ASIC
GigaDevice Semiconductor	NA	$75	$97	$96	$93	$178	$215	$240	$283	NM	NOR Flash Memory
Montage	$0	$0	$0	$100	$150	$200	$220	$225	$270	NM	Memory interface design
Leadcore Technology	$117	$128	$103	$152	$115	$218	$228	$235	$242	9%	Mobile processors
Allwinner Technology	NA	$50	$168	$246	$185	$181	$187	$179	$206	NM	Tablet/audio processors
Fuzhou Rockchip Electronics	$58	$82	$108	$216	$152	$152	$191	$179	$182	16%	Tablet/audio processors
Datang Microelectronics Technology	$74	$92	$116	$151	$131	$146	$132	$86	$89	8%	Smart card ICs
Beijing Ingenic	NA	NA	NA	NA	NA	$11	$16	$26	$37	NM	Acquired Omnivision
Top 20 China fabless	**$2,153**	**$3,768**	**$4,359**	**$6,357**	**$7,928**	**$9,601**	**$11,262**	**$13,731**	**$16,808**	**23%**	
YoY Growth		**75%**	**16%**	**46%**	**25%**	**21%**	**17%**	**22%**	**22%**		
Top China fabless market share	**3.8%**	**6.0%**	**6.4%**	**8.4%**	**9.3%**	**10.7%**	**12.7%**	**14.1%**	**16.2%**		
BRCM	$6,818	$7,389	$8,006	$8,305	$8,388	$8,472	$13,292	$17,665	$20,029	9%	Networking/Broadband
AVGO	$2,093	$2,336	$2,364	$2,520	$4,269	$4,300	In BRCM	In BRCM	In BRCM	NM	RF/Storage/Networking
LSI (Acquired by Avago)	$1,870	$2,044	$2,506	$2,370	In Avago	In Avago	In BRCM	In BRCM	In BRCM	NM	Storage/Networking
QCOM QCT	$7,204	$9,828	$13,177	$17,211	$19,291	$16,008	$15,415	$17,029	$16,581	10%	Mobile Processors
NVDA	$3,543	$3,998	$4,280	$4,130	$4,682	$5,010	$6,910	$9,714	$11,716	9%	Graphics
MediaTek	$3,605	$2,956	$3,358	$4,586	$7,030	$6,718	$8,549	$7,832	$7,902	11%	Mobile/Digital Home
AMD (+ ATYT)	$6,668	$6,748	$5,616	$5,481	$5,668	$4,111	$4,272	$5,253	$6,506	-5%	Processors/Graphics
XLNX	$1,896	$2,437	$2,315	$2,256	$2,485	$2,447	$2,334	$2,485	$2,658	3%	Programmable Logic
MRVL	$2,808	$3,612	$3,393	$3,169	$3,404	$3,707	$2,726	$2,393	$2,416	0%	Networking/Connectivity
ALTR	$1,954	$2,064	$1,783	$1,733	$1,932	$1,971	$2,010	$2,050	$2,091	0%	Programmable Logic
Novatek	$1,153	$1,193	$1,253	$1,397	$1,784	$1,602	$1,416	$1,548	$1,820	3%	Driver ICs/Display
Top global fabless	**$39,613**	**$44,605**	**$48,052**	**$53,158**	**$58,933**	**$54,346**	**$56,924**	**$65,969**	**$71,719**	**5%**	
YoY Growth		**13%**	**8%**	**11%**	**11%**	**-8%**	**5%**	**16%**	**9%**		
Top global fabless market share	**69.5%**	**70.5%**	**70.6%**	**69.9%**	**69.4%**	**60.5%**	**64.3%**	**67.6%**	**69.0%**		
China top 20 fabless	**$2,153**	**$3,768**	**$4,359**	**$6,357**	**$7,928**	**$9,601**	**$11,262**	**$13,731**	**$16,808**	**23%**	
Overseas fabless revenue	**$54,833**	**$59,526**	**$63,688**	**$69,656**	**$77,045**	**$80,172**	**$77,288**	**$83,883**	**$87,197**	**4%**	
Global fabless revenue	**$56,986**	**$63,294**	**$68,047**	**$76,013**	**$84,973**	**$89,773**	**$88,550**	**$97,614**	**$104,005**	**6%**	
YoY Growth		**11%**	**8%**	**12%**	**12%**	**6%**	**-1%**	**10%**	**7%**		

Source: Company data, Credit Suisse estimates

For China, the market has also been growing at a 20-25% CAGR in the past decade, driven by the government's initiative to support local semiconductor ecosystem and HiSilicon's success in smartphone chipset supplying to its parent company, Huawei, and its share gains in networking equipment market in 4G and the upcoming 5G.

Despite a potentially slower year in 2020 due to the COVID-19 outbreak, we believe fabless should see momentum pick up from 2021, supported by multiple drivers including 5G infrastructure builds, smartphone replacement cycle with higher semiconductor content in 5G smartphones, rising penetration for cloud and edge AI computing, and continued data centre investment. In China, we believe the growing trade and technology tension between the US and China has been forcing the local ecosystem to accelerate the silicon development to ensure it can control the technology. The demand from import substitution in China should drive a wave of IC design projects from the existing fabless and the new fabless or system companies.

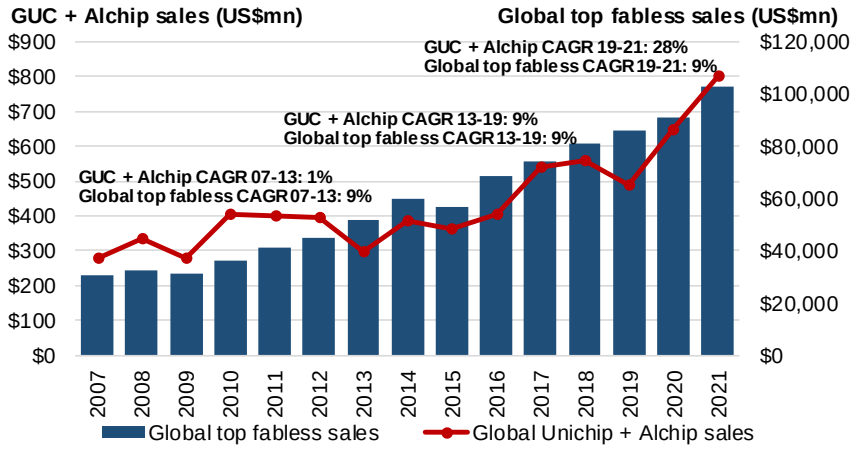
Outside fabless, we expect the start-ups and system companies to develop more customised ICs for their own use in cloud computing (e.g., cloud training and inference) and supply the core processors to customers adopting their cloud solutions.

We believe the trends of China import substitution and global AI and cloud computing development will be important drivers for the IC design service industry, especially for Global Unichip and Alchip, the two largest IC design service companies for high performance computing and communication applications in Taiwan. We note that GUC's and Alchip's sales growth from 2007-13 has been only at 1% CAGR, lagging fabless at 9% due to a wave of consolidation in the industry and industry growth led by a consolidating smartphone chipset market.

However, IC design service growth has picked up since 2014, when high-performance computing became a trend supported by the manufacturing technology migration, with GUC's

and Alchip's sales accelerated to 9% from 2013-19, in line with global fabless. We believe the IC design service has been one of the key beneficiaries of the surge in investment by the start-ups and system companies, first from blockchain/crypto-currency but more recently from growth in cloud computing AI and supercomputing applications, that has helped form a new wave of start-ups, system companies, and also China domestic chip companies.

Figure 12: Taiwan IC design service business accelerates with growing HPC demand



Source: Company data, Credit Suisse estimates

With the industry getting more consolidated to those with access to advanced manufacturing process, IP and EDA tools, we expect the opportunity for Taiwan IC design service companies to be in ASIC design for the applications across communication, consumer, HPC and automotive industry including mature data centre, IoT, drone, robotics, artificial intelligence (AI), machine learning, 5G networking, and ADAS.

Figure 13: TSMC sees HPC demand as a key driver for the company

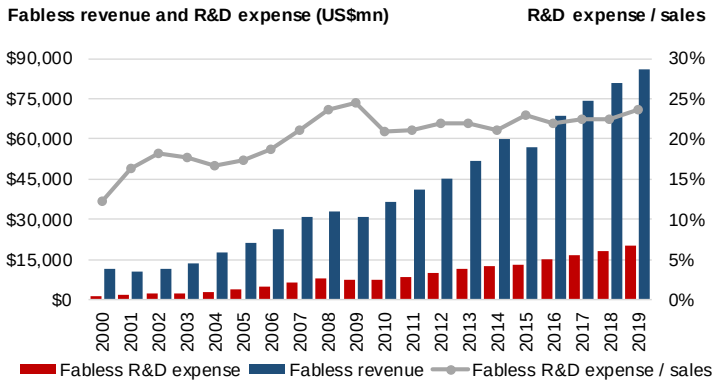
HPC Silicon Market	2015	2016	2017	2018	2019	2020	2021	15-20 CAGR
Servers and CPUs	$14.4	$15.4	$16.8	$20.6	$22.6	$24.8	$27.3	**11%**
Graphics and Gaming	$7.1	$8.4	$10.9	$13.0	$12.4	$13.8	$15.1	**14%**
AI Accelerators	$0.34	$0.8	$1.9	$3.5	$4.0	$6.0	$7.8	**78%**
Cryptocurrency	$0.3	$0.4	$2.5	$3.3	$1.0	$2.0	$2.0	**NM**
Programmable Logic	$4.4	$4.3	$4.5	$4.7	$5.4	$5.8	$6.2	**6%**
Networking & Infrastructure	$13.0	$13.2	$14.1	$14.6	$15.6	$16.4	$18.04	**5%**
Computing Peripherals	$8.0	$7.8	$7.7	$7.5	$7.4	$7.2	$7.1	**-2%**
HPC - Market	**$47.5**	**$50.4**	**$58.5**	**$67.3**	**$68.3**	**$76.0**	**$83.6**	**10%**
HPC Wafer Opportunity	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**15-20 CAGR**
Servers and CPUs	$6.5	$6.9	$7.6	$9.3	$10.2	$11.2	$12.3	**11%**
Graphics and Gaming	$2.7	$3.2	$4.1	$4.9	$4.6	$5.2	$5.7	**14%**
AI Accelerators	$0.1	$0.2	$0.4	$0.8	$0.9	$1.3	$1.8	**78%**
Cryptocurrency	$0.2	$0.2	$1.3	$1.7	$0.5	$1.0	$1.0	**NM**
Programmable Logic	$1.0	$1.0	$1.1	$1.3	$1.5	$1.6	$1.7	**9%**
Networking & Infrastructure	$4.4	$4.5	$4.8	$4.9	$5.3	$5.5	$6.1	**5%**
Computing Peripherals	$3.4	$3.4	$3.3	$3.2	$3.2	$3.1	$3.0	**-2%**
HPC - Market	**$18.2**	**$19.3**	**$22.5**	**$26.1**	**$26.2**	**$29.0**	**$31.6**	**10%**
TSMC estimates (CS)	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**15-20 CAGR**
Servers and CPUs	$0.0	$0.0	$0.0	$0.3	$0.5	$1.3	$2.1	**NM**
Graphics and Gaming	$2.0	$2.0	$2.4	$3.7	$3.6	$3.9	$3.52	**14%**
AI Accelerators	$0.1	$0.2	$0.4	$0.8	$0.9	$1.3	$1.7	**76%**
Cryptocurrency	$0.1	$0.2	$1.3	$1.6	$0.4	$0.6	$0.6	**NM**
Programmable Logic	$0.7	$0.7	$0.7	$0.9	$1.1	$1.2	$1.3	**12%**
Networking & Network Processors	$1.6	$1.6	$1.8	$2.0	$2.2	$2.3	$2.31	**7%**
Computing Peripherals	$1.4	$1.4	$1.4	$1.7	$1.7	$2.0	$1.9	**7%**
HPC - TSMC	**$5.9**	**$6.1**	**$8.1**	**$11.0**	**$10.3**	**$12.6**	**$13.3**	**17%**
TSMC share of HPC production	**32%**	**32%**	**36%**	**42%**	**39%**	**43%**	**42%**	

Source: Company data, Credit Suisse estimates

The higher R&D requirement in the advanced nodes is also providing the IC design service companies with more opportunities as their customers are more cautious on the investment in the leading edge technology. We estimate global fabless' R&D expense/sales to be growing from 13-18% in 2000-05 to low-20% levels in the past decade, and is now approaching 25%,

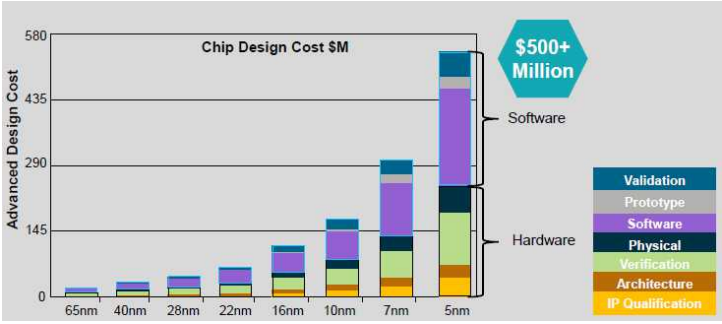
as major fabless migrate to 7nm and below nodes. According to Synopsys, the chip design cost has also grown meaningfully to US$500 mn+ on 5nm (vs US$150 mn on 10nm and US$30-40 mn on 28nm). We believe the high risk for the start-ups and system companies who lack the experience in semiconductor design and manufacturing is the expansion of the addressable market for IC design service companies in advanced nodes.

Figure 14: Fabless' R&D/sales get higher as technology advances



Source: Company data, Credit Suisse estimates

Figure 15: Chipset design cost has surged from US$30-40mn on 28nm to US$500 mn+ on 5nm



Source: Synopsys

Competitive landscape for design services

The design service capability and capacity, IP portfolio, success rate, supply chain relationship, target applications and technology/IP support are the important factors when customers choose their service provider. We compare the competiveness for the major companies, including Global Unichip, Alchip, and Faraday in Taiwan and VeriSilicon in China as below.

Figure 16: Performance, technology, and target application comparison for major IC design service companies

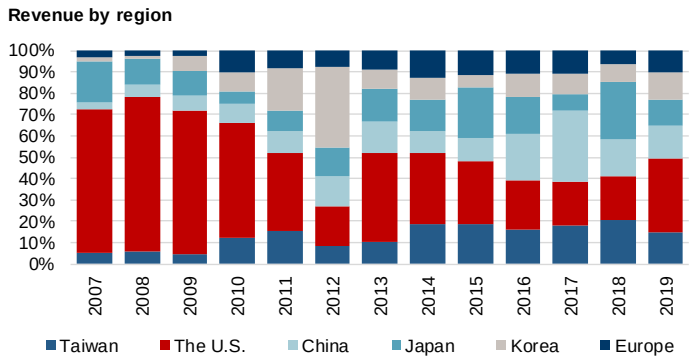
IC design service company	Global Unichip	Alchip	Faraday	VeriSilicon
Ticker	3443.TW	3661.TW	3035.TW	Pending
Revenue (US$mn)	$346	$140	$172	$191
GMs	27.5%	35.6%	44.6%	40.2%
OpMs	6.5%	10.0%	7.5%	-4.7%
Headcounts	759	404	882	936
Service	Front/back-end design, IP	Front/back-end design, IP	Back-end design	Front/back-end design, IP
Technology support	**65nm and above:** 30% **40nm:** 13% **28nm:** 37% **16nm:** 16% **7nm and below:** 4%	**55nm and above:** 4% **40nm:** 6% **28nm:** 29% **20/16nm:** 33% **12/7nm:** 27%	**0.25um:** 0-5% **0.18-0.11um:** 35-40% **90-55nm:** 20-25% **40nm:** 15% **28nm and below:** 20-25%	**28nm and below:** 85% **28nm and above:** 14%
Targeted applications	**Computer:** 43% **Consumer:** 34% **Communication:** 11% **Others:** 12%	**HPC:** 59% **Network:** 14% **Niche:** 18% **Consumer:** 9%	**Industrial:** 30-35% **AIoT:** 30-35% **Communication:** 20% **PC:** 10-15% **Others:** 0-5%	**Consumer:** 38% **IoT:** 24% **Data processing:** 20% **Industrial:** 10% **PC:** 4% **Automotive:** 4%
Foundry partners	TSMC (100%)	TSMC (~100%), Samsung, SMIC, GlobalFoundries	UMC (70-75%), Samsung (20-25%)	SMIC (30%), Samsung (5-10%), GlobalFoundries (5-10%), Hua Hong, TSMC

Source: Company data, Credit Suisse estimates

Global Unichip: The company is the largest IC design service company in Taiwan, providing both front-end and back-end IC design service with its customers, with revenue reaching NT$10 bn in 2019 at GMs of 33%. The company generates 70%+ revenue from 28nm with a target on computing (44% of its sales) and consumer applications (33% of its sales).

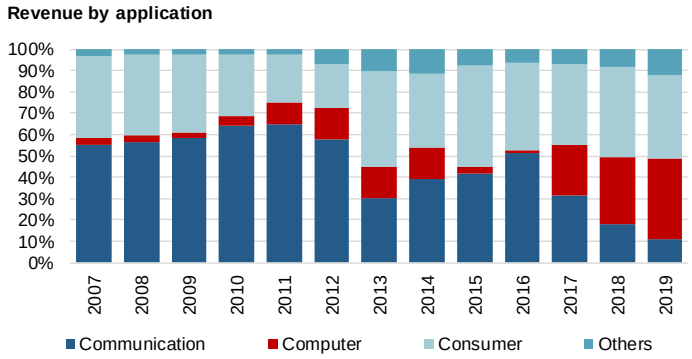
Compared with the high exposure in China for Faraday and Alchip, Global Unichip's is more diversified, with the US and Taiwan contributing to 50% of its sales. As one of TSMC's subsidiary, the company gets the support from TSMC on IP library and manufacturing, even during the supply tightness in advanced nodes. Global Unichip is also leading in technology development among its Taiwan peers, with 5nm silicon verified by the end of last year.

Figure 17: Global Unichip's revenue by region



Source: Company data, Credit Suisse estimates

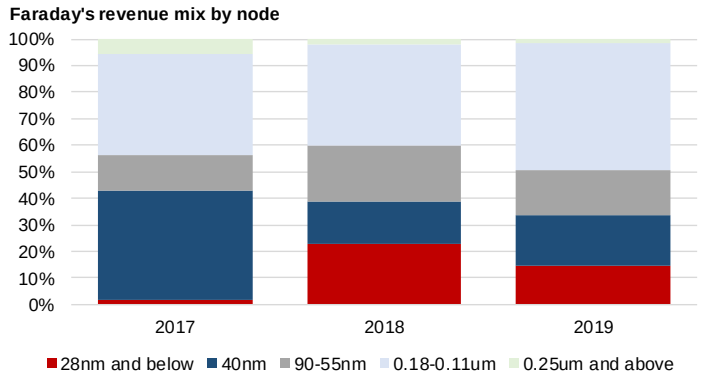
Figure 18: Global Unichip's revenue by application



Source: Company data, Credit Suisse estimates

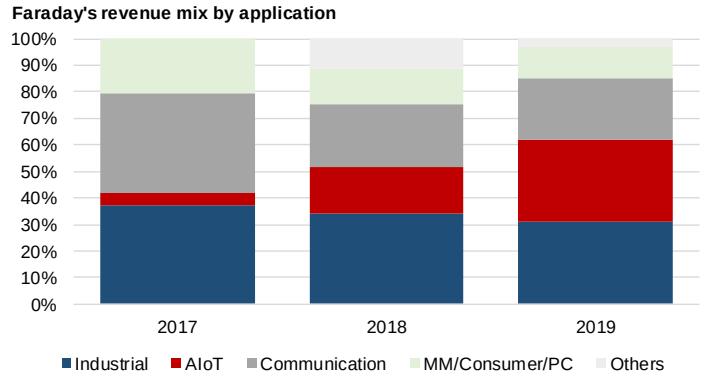
Faraday: The Company is a spin-off of UMC, with revenue of NT$5.3 bn and GMs of 50% in 2019. Although the company has started its partnership with Samsung foundry for advanced nodes, with its main partnership with UMC, the company has been lagging in technology development and revenue growth in the past few years (sales have been flat since 2017) and it has a different product mix compared with its peers. Faraday's revenue from 28nm and below only contributes to 16% of its sales, 35% from 40-90nm and 46% on 8". On product mix, with limited access to advanced nodes for HPC and mobile related applications, the company has higher exposure in AIoT (44% of its sales) and industrial (22% of sales) applications, with key revenue drivers in 2019 including printer, projector, POS machine, smart meter and medical applications.

Figure 19: Faraday's revenue by node



Source: Company data, Credit Suisse estimates

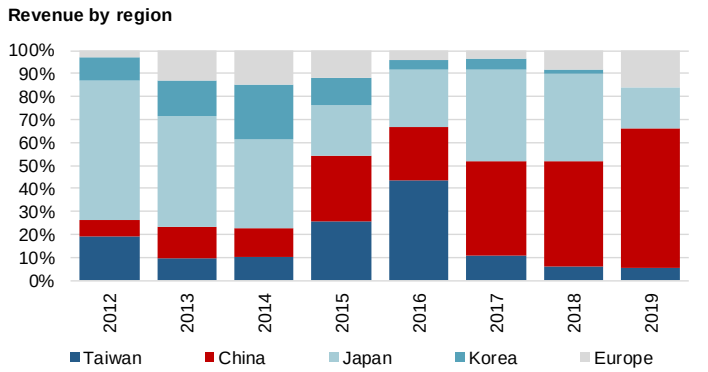
Figure 20: Faraday's revenue by application



Source: Company data, Credit Suisse estimates

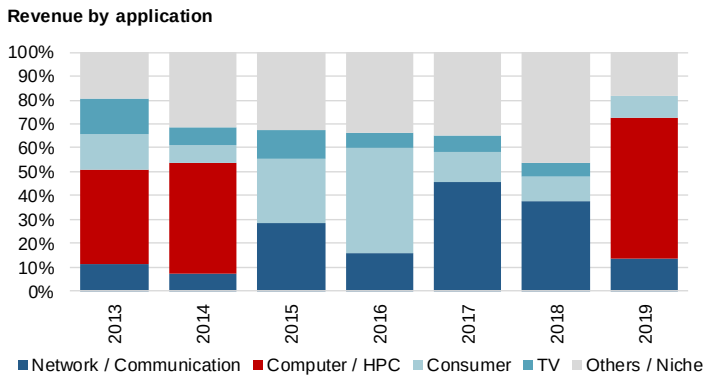
Alchip: Alchip was founded in 2003 by a group of semiconductor veterans to focus on the leading edge ASIC and SoC design, revenue reached NT$4.3 bn in 2019 at 37% GMs. With its strategy to put resource on HPC and AI projects, the company generates 26% of its revenue from 12/7nm, 53% from 20/16nm and 11% from 28nm. The company also has the highest exposure to China among major Taiwan IC design service companies at 60%, as it is designing CPU and AI chipsets for its China customers, mainly for government projects. In addition to China, the company is also aggressively working with the US internet companies for ASIC design opportunities, and has recently won a game console project from its Japanese customer.

Figure 21: Alchip's revenue by region



Source: Company data, Credit Suisse estimates

Figure 22: Alchip's revenue by application



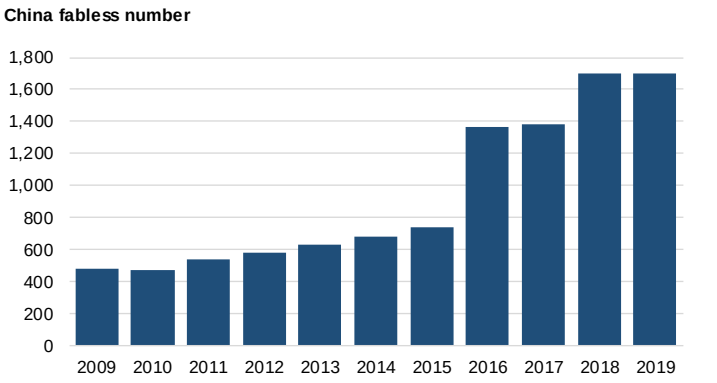
Source: Company data, Credit Suisse estimates

Verisilicon: Verisilicon was founded in 2001 by Dr Wei-Ming Dai (brother of Marvell co-founder Weili Dai), the ex-professor at UCSC, and Mr Wei-Jin Dai, ex-VP of Cadence. The company's business includes the semiconductor IP licensing (GPU, NPU, VPU, DSP, ISP, analog and mixed IP) and IC design service. The company has plans to list in China STAR market and has submitted its prospectus.

For the funding from IPO, the company targets to raise up to Rmb790 mn (~US$120 mn) for key projects, including IP development for wearables, smart automotive and smart home, building up ASIC development platform for cloud computing and R&D centre upgrade. On supply chain management, in contrast to most of the Taiwan IC design service companies who in general have a primary foundry partner, Versilicon has been maintaining a multiple sourcing strategy to meet its customers' demand, with major foundry partners including SMIC, Samsung, Global Foundries, Hua Hong, and TSMC, and back-end partners including ASE, JCET, King Yuan, Tianshui Huatian, and Powertech. To ensure the chipset design is optimised for customers' requirement, the company also provides third-party IP in addition to its solutions.

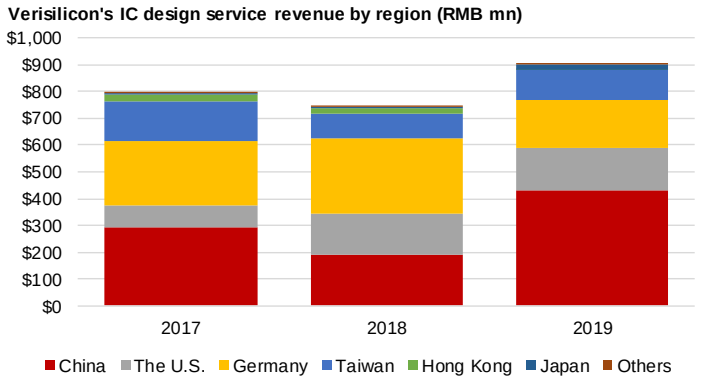
As the largest IP and IC design service provider, the company should benefit from the fast growth in China semiconductor ecosystem. Based on its estimate, the number of China fabless has grown from 500 in 2010 to current over 1,600, with most of them established since 2016, and targeting diversified applications across low-end consumers and communication peripheral chipsets to core ASICs and CPU for cloud and edge computing.

Figure 23: Number of China fabless growing fast since 2014



Source: IBS, Credit Suisse

Figure 24: Verisilicon's IC design service revenue by region



Source: Company data, Credit Suisse estimates

We note that for the company's IC design service business, the revenue from its China customers has been growing in importance, from 25-35% in 2017-18 to close to 50% in 2019, suggesting acceleration in IC design activities in China and the need to have support from IC design service companies due to their lack of scale and experience.

The company's NRE projects in advanced nodes have also been growing in the past few years, with 28nm and below growing as % of total projects. We believe it is mainly driven by its technology development, with support through 7nm now, and 5nm platform under development. The company is also partnering with its foundry partners in advanced nodes, including GlobalFoundries on FD-SOI, SMIC on 14nm and Samsung on 14nm and 10nm. By application, the company's revenue contribution in its IC design service is mostly from consumer, IoT on 0.18um, 28nm, 22nm and 14nm and data processing on 14nm and 10nm, with video decoder for Facebook as the most noticeable project.

Figure 25: Verisilicon has been working on more 28nm and below projects, though majority still on mature nodes

Verisilicon NRE projects	Tape outs			Under development			NRE revenue (RMB mn)			Major applications	Customers
	2017	2018	2019	2017	2018	2019	2017	2018	2019	2019	2019
14nm and below	1	5	8	9	12	18	$46	$136	$197	Consumer, Data processing	Blaize, NXP, Facebook, Cyrus, Orbita
22nm	1	4	3	3	5	8	$11	$24	$65	IoT	
28nm	12	11	3	22	18	16	$94	$91	$52	IoT, PC and peripheral	
65-28nm	9	13	9	37	37	37	$38	$34	$34	Automotive, Industrial	
65nm and above	18	17	8	47	49	52	$19	$21	$18	Automotive, Industrial, Consumer	
Others	NM	NM	NM	14	10	18	$3	$1	$3		
Total	**41**	**50**	**31**	**132**	**131**	**149**	**$211**	**$306**	**$369**		

Source: Company data, Credit Suisse estimates

For the company's business, its sales grew 26% YoY to Rmb1.3 bn, with the IC design service business outgrowing the company and contributing close 70% of its sales, while the rest is from the IP licensing and royalty revenue. Compared with its Taiwan peers, the company's NRE margins was lower at only 17% in 2019, offsetting 90%+ margins from its IP business and dragging corporate average margins to only 40%. We believe the lower-than-peers' GMs for its IC design service business is mainly due to more low margin consumer business from its China customers, while the company has not capitalised the mask cost which represents a high portion in its cost structure, especially the cost for mask is high in advanced nodes.

Figure 26: Verisilicon's IC design service business is a drag to its profitability

Verisilicon	Revenue			GMs		
IC design service	**2017**	**2018**	**2019**	**2017**	**2018**	**2019**
NRE	$211	$306	$369	11%	18%	17%
Turnkey	$590	$440	$533	16%	18%	12%
IC design service revenue	**$800**	**$746**	**$902**	**15%**	**18%**	**14%**
IP license / royalty	**2017**	**2018**	**2019**	**2017**	**2018**	**2019**
Licensing	$200	$214	$343	90%	95%	93%
Royalty	$80	$97	$95	100%	100%	100%
IP license / royalty revenue	**$280**	**$312**	**$438**	**93%**	**96%**	**95%**
Versilicon total	**$1,080**	**$1,057**	**$1,340**	**35%**	**41%**	**40%**

Source: Company data, Credit Suisse estimates

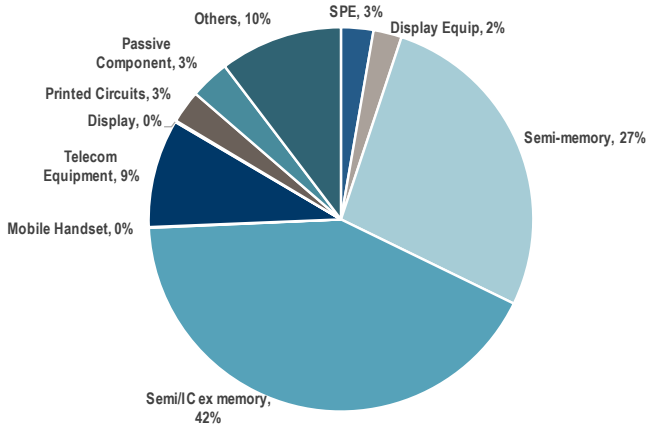
With the company's focus is on China domestic market, and it targets to build cloud computing platforms for its local customers for chipset localisation in the next few years, we believe the company would be a modest threat for the Taiwan IC design service companies with higher China exposure (e.g., Faraday and Alchip).

We believe the competition could be fiercer for Faraday due to its high overlap with Verisilicon in the IoT and consumer market, while the foundry support from UMC and Samsung would not be an advantage for Faraday. The competition for Alchip from Verisilicon may still be a few years away as it already has a strong project pipeline with local CPU fabless Phytium and other HPC projects, and its strong relationship with TSMC in advanced nodes in the past decade should keep Alchip as a preferred IC design service partner for China's leading fabless who want access to the most leading edge manufacturing technology.

Design service leveraged to China's CPU localisation

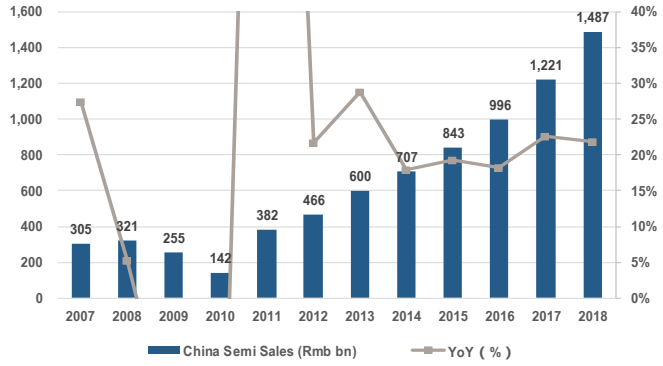
With a high portion of all tech-related imports by China being semiconductor products, the focus of Chinese authorities has been to develop a local semiconductor industry. Geopolitical developments in recent years, particularly the inclusion of several Chinese entities (notably Huawei, Hikvision amongst others) by the US on its restricted Entity List, further adds urgency to China's initiatives to localise the tech industry and reduce its import dependence.

Figure 27: Total China tech imports breakdown, 2018 (%)



Source: IDC

Figure 28: China semi industry revs and YoY growth

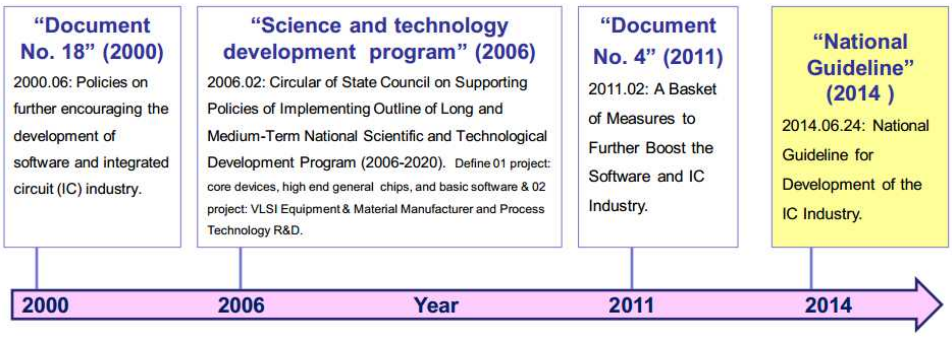


Source: IDC

While the focus on developing a domestic Semi industry has borne some fruit – local semis production has been growing at a 20% CAGR in recent years (including semi production by global players out of their China-based facilities) – China, as discussed in the previous section, remains a large importer of semiconductors, and hence, the need to continue to focus on developing the local industry.

Chinese IC industry policy timeline

Figure 29: China IC industry policies progress since 2000


"Document No. 18" (2000)
2000.06: Policies on further encouraging the development of software and integrated circuit (IC) industry.
"Science and technology development program" (2006)
2006.02: Circular of State Council on Supporting Policies of Implementing Outline of Long and Medium-Term National Scientific and Technological Development Program (2006-2020). Define 01 project: core devices, high end general chips, and basic software & 02 project: VLSI Equipment & Material Manufacturer and Process Technology R&D.
"Document No. 4" (2011)
2011.02: A Basket of Measures to Further Boost the Software and IC Industry.
"National Guideline" (2014)
2014.06.24: National Guideline for Development of the IC Industry.
2000
2006
Year
2011
2014

Source: SEMI

The government has had several policies before, starting notably with the State Council Document 18 to develop its IC industry in 2000. This policy offered favourable tax treatment to domestic IC chips and government investment in infrastructure, education, and basic research. In 2005, the US petitioned the WTO to drop the VAT rebates for China IC producers, however, some of the favourable industry policies stayed in effect, with the full document in effect through the end of 2010. The policy did lay the ground work for the domestic industry, building

it up to close to 10% of industry production by the time of the financial crisis and US$23 bn of sales, according to CCID.

China's State Council supplemented the policy with its guidelines on Scientific Technology development in 2006 for the next 15 years. It set a target for R&D at 2.5% of China's GDP, with interim targets by 2020 to increase science and technology to 60% of the country's development and lowered reliance on foreign technology to less than 30%. The policy supports a Science and Technology development programme with projects to develop core devices, high-end chips, equipment and materials. China has prioritised technology development and has set the target to reach the Top 5 spot in patents.

Figure 30: China's 2014 National IC Guideline sets aggressive targets for its chip industry

	2015	2020	2030
Semiconductor Revenue	>350bn RMB (US$55bn)	>870bn RMB (20% Growth CAGR)	World class IC industry value chain
IC Manufacturing	32/28nm mass production	16/14nm mass production	A set of leading tier 1 global semi players
IC Design	Approach international standards in some technologies (smartphones, networking)	Reach international leading edge in key technologies (mobile, networking, cloud computing, IoT, big data)	
IC Package and Test	>30% of sales from advanced packaging	Competitive with the global leaders	
IC Materials	12" silicon wafers in the production line	Competitive in the global supply chain	
Semi. Equipment	65-45nm tools in the production line	Competitive in the global supply chain	

Source: SEMI, China's National Guideline 2014, Credit Suisse

The China government passed the National IC Development Guideline in 2014 and 'Made in China 2025' initiatives in 2015, jumpstarting the latest wave of industry developments to build the local semiconductor industry, this time directing more public and private resources for the initiative. The key outcome from the guidelines is to achieve 20% of semiconductor industry revenue growth to US$143 bn by 2020E (Rmb870 bn), raising China's internal supply of silicon from one-third to half in order to reduce import dependence and stimulate the economy to move up the value chain from manual labour intensive to high-skilled technology intensive industries.

The national policy laid out aggressive plans behind its 20% growth rate to achieve global competitiveness across chip manufacturing, fabless IC design, back-end package and test, materials and equipment. By 2020, the target is to move up from one third to half of its chips from domestic production, reach competitiveness in a number of advanced silicon capabilities (IoT, networking, cloud computing, big data), enter FinFet mass production, and have back-end, equipment and materials solutions to be competitive enough to serve the global supply chain. Ultimately by 2030, China's target is to have a world class IC value chain with a set of top-tier global chip players.

CPU localisation a key priority for Chinese government

China has been actively building its own operating system and processors to try to control the IT ecosystem and also enhance national security under the HGJ project (core electronic devices, high-end generic chips, and basic software) during the 11th 5-year plan. The pace of the development has modestly accelerated after Microsoft blacked out the Windows system on a wide range of the PCs in China with pirated software in 2009 and the break out of PRISM in 2014. However, the progress was slow due to lack of technological knowledge and capability in the semiconductor industry, while the build-up of software ecosystem does take a lot of time.

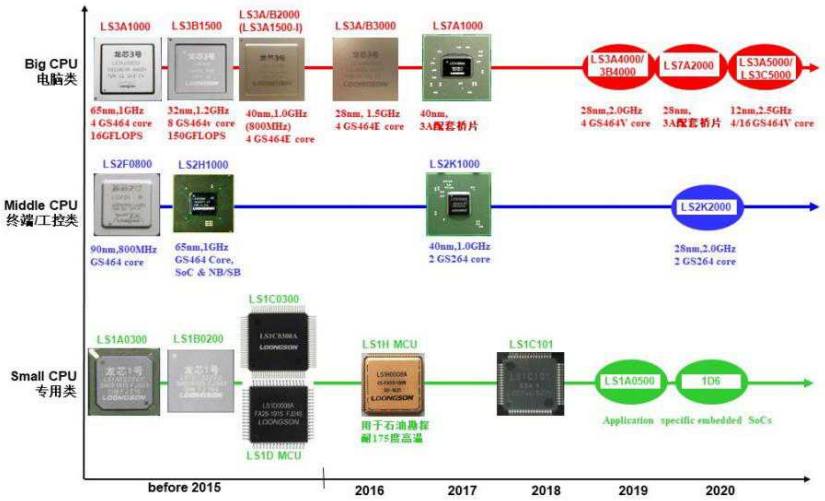
The inflection point was a series of moves by the US government on China, including (1) supercomputing system's access to Intel's most advanced Xeon chipsets due to concerns on national security in 2015, (2) adding ZTE on the entity list in 2016, (3) adding Huawei and its affiliates on the entity list in 2019 and full ban on the access to US technology in 2020, (4) stopping ASML from shipping EUV tools to SMIC, and (5) requiring AMD to end support for its CPU JV with its China partner Hygon. The US government's direct counter-China action added the urgency for China government to ramp its semiconductor ecosystem more aggressively, with CPU replacement for government PC/NB and servers becoming high priority.

Following the development in the past decade, the ecosystem developed by China local CPU fabless has been more comprehensive, with major players including Loongson, Phytium,

Kunpeng, Sunway, Zhaoxin and Hygon. We introduce the development of these companies and compare the chipsets in the section below.

Loongson – MIPs based CPU for PC and servers: The Company was set up by the China Institute of Computing Technology and currently has ~500 employees. It has been focusing on developing its own instruction set and architecture based on MIPS. The latest chipsets include Loongson 3A introduced in 2017 with derivative Loongson 3A4000 built on STMicro's 28nm FD-SOI process. The company shipped 800k CPU in China in 2019 and targets to launch LS3A5000 for PC in 1H20 and LS3C5000 in 2H20 for server migrating to SMIC's 12nm. With self-developed instruction sets, the company claims its solutions have high security level. However, the lack of software support and industry alliance keeps its chipsets only suitable for limited use.

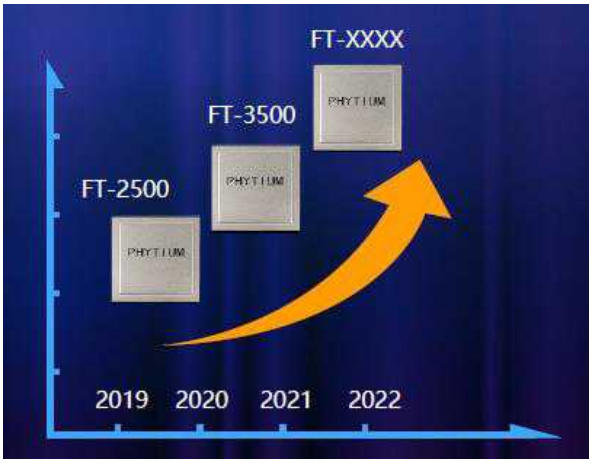
Figure 31: Loongson's chipset roadmap – targeting to migrate from 28nm to 12nm



Source: Loongson

Phytium – ARM based CPUs for PC and server: The Company was set up by the China National University of Defense Technology and has now merged into China Great Wall Technology. Phytium has shifted its focus from developing CPU with SPARC structure to ARMv8 architecture with a permanent license from 2012.

Figure 32: Phytium's roadmap for PC and server chipsets



Source: Phytium

Figure 33: China government could replace Wintel with Phytium CPU + Kylin OS when the ecosystem is more mature

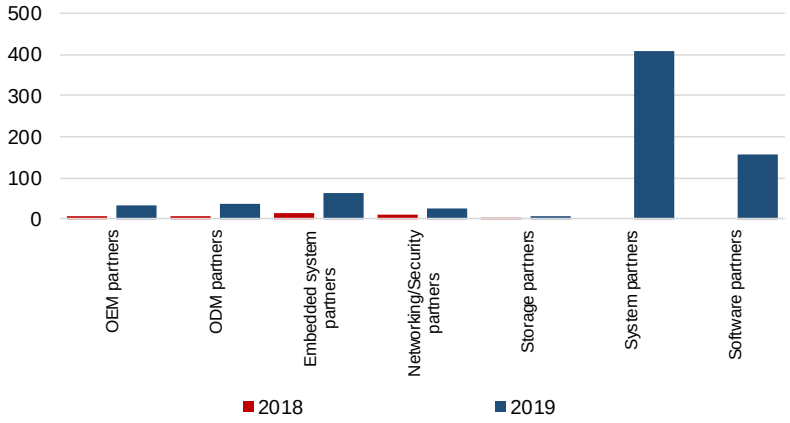
Source: Phytium

Due to its relatively small scale (400) and more distant relationship with TSMC, Phytium focuses on front-end design, while working with Alchip and EE2 on back-end design. Alchip's

close ties to TSMC and its PDKs keeps this relationship intact with plans already for co-working on projects through at least 2022. Phytium has successfully launched FT-1500 series CPU on 40nm and FT-2000 series on 28nm in 2016 and FT-2000/4 for PC/NB on TSMC's 16nm in 2019. The company plans to launch its 64 core FT-2000/64 for server in 2H20.

The company at its ecosystem conference in late 2019 announced its five-year plan which targets to grow its annual sales to Rmb10bn by 2024, with employees reaching 3,000 by 2023, this supported by strong local ecosystem across cloud computing (Aliyun, Kylin, Tencent, ZTE, Inspur, UniCloud), server and PC ODMs (Lenovo, Inspur, Sugon, Tsinghua Tongfang, Hisense, Haier, Cloud Kirin, Great Wall), OS (Kylin, Ubuntu) to apps, security and service. The company's advantage over its CPU fabless peers in China is that its processors is optimised to run Kylin OS which has been developed by the National University of Defense Technology, and intended for use by government offices, national defense, energy and large SOEs.

Figure 34: Phytium's ecosystem in China has been growing fast across OEM, new model design, software and security



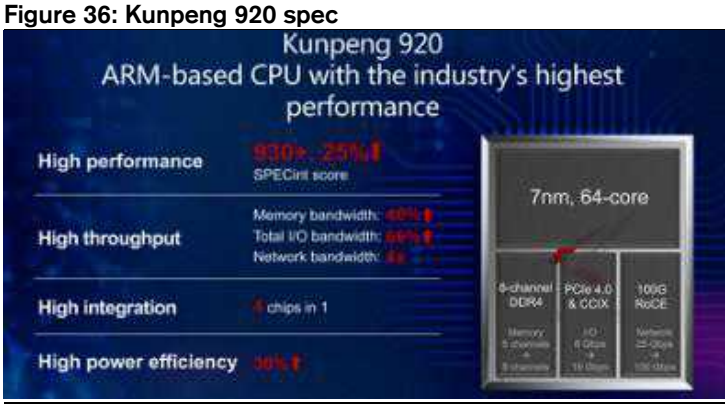
Source: Phytium

Huawei's Kunpeng Subsidiary for HPC: The Company is a business of Huawei Group focusing on the ARM based chipset design for PC and server across computing, network, storage and management. The group has been actively developing high-performance computing chipsets, but now would be impacted by the US Commerce Department restrictions requiring foundries to have an equipment license to fab Huawei and its affiliates' chipsets. Huawei had been making strides; with the most noticeable case being the Kunpeng 920 manufactured on TSMC's 7nm is adopted in Huawei's Taishan servers for Huawei's cloud platform, providing 30% higher performance or 20% less power consumption.

Figure 35: Huawei Kunpeng HPC Solution Stack

Source: Kunpeng

Figure 36: Kunpeng 920 spec

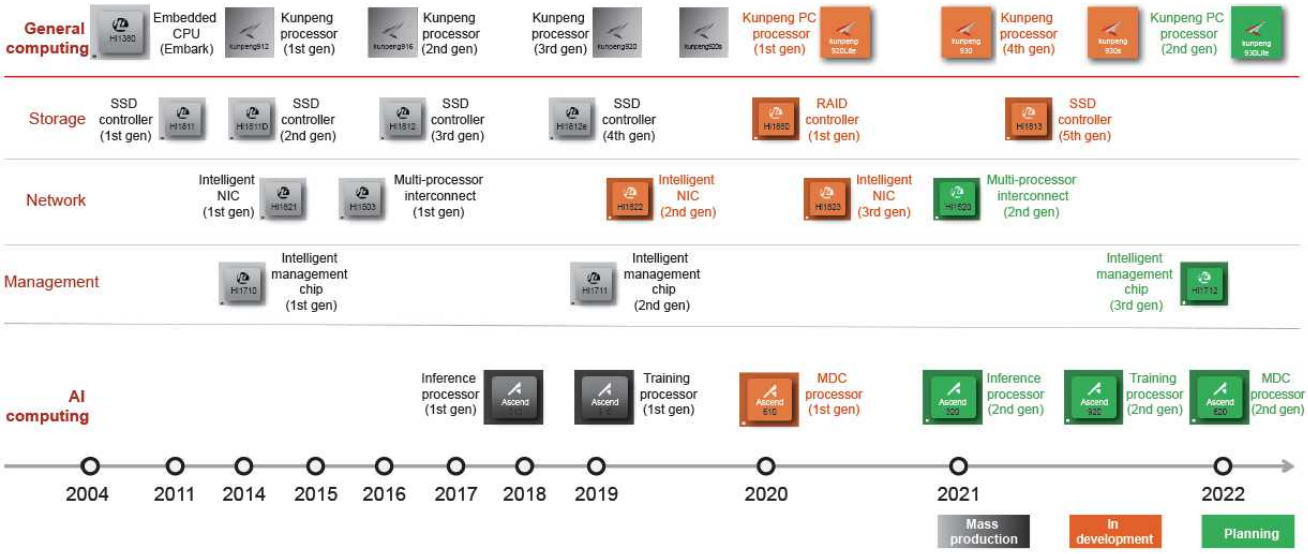


Source: Kunpeng

The company, if it could overcome the US restrictions, had plans to develop Kunpeng 930 for launch in 2021 and has Kunpeng 950 in its roadmap in 2023. Kunpeng noted there are more

than 150 vendors participating in the Kunpeng computing industry for an integrated solution from edge to cloud, and it plans to roll out more chipsets along with its open source community to drive growth, not only in the government sector but also in the commercial market.

Figure 37: Kunpeng's chipset roadmap – a wide range of solutions for PC and server



Source: Kunpeng

Sunway PC/Server chipsets for military use, with China developed Alpha instruction set: Sunway is developed by the National High Performance Integrated Circuit Design Center in Shanghai. The chipsets developed by Sunway is based on Alpha instruction set. Although the ecosystem support is also limited compared with ARM, Sunway's chipsets are mostly for military use. The company's chipset solutions can be used in server, PC and HPC but the manufacturing technology is lagging, with most of them on 0.13um to 40nm. SW26010 built on high-performance CPU is the only one on 28nm and is adopted in Sunway's TaihuLight supercomputing system.

Figure 38: Sunway's chipset solutions span from PC to HPC

芯片类别	主要产品	在研
嵌入式CPU	SW111 SW121	
桌面CPU	SW400、SW410、SW411、SW411s、SW421	
服务器CPU	SW1600、SW1610、SW1621	SW3231
高性能CPU	SW26000、SW26010 SW26020	
IO芯片	SW-ICH1、SW-ICH2	SW-ICH3

Source: Sunway

Figure 39: Sunway's HPC chipsets adopted in supercomputers

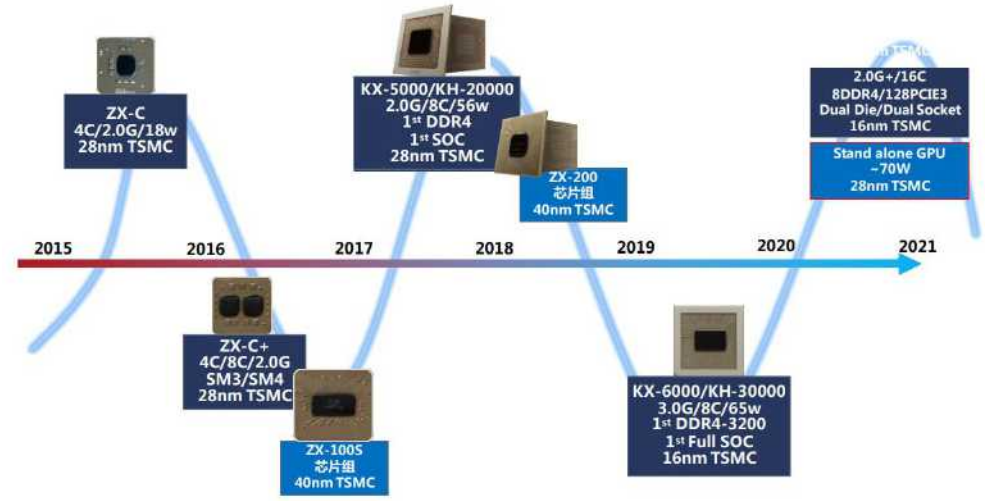
Source: Sunway

Hygon – Former AMD JV for x86 chipsets: The Company's chipsets are based on AMD's Zen architecture licensed in 2016. However, the development is behind, as compared with other peers due to a slower start and the x86 architecture cannot be fully controlled by the China government. The company was added to the US entity list in 2019 and most of its projects have been stopped or pushed out as AMD was also required to fully cooperate.

Zhaoxin – x86 CPUs backed by Taiwan'Via: The Company was set up as a JV between VIA and Shanghai Zhaoxin Semiconductor in 2013 with close to 1,200 employees. The company licensed the x86 architecture from VIA to develop its own CPU and GPU, and relies on Huali for 28nm and above and TSMC on the advanced nodes for manufacturing. The company also

introduced its KX-6000 series CPU on 16nm which is adopted by HP's PC, while its KH-30000 series is also on 16nm for server.

Figure 40: Zhaoxin's chipset roadmap – migrating to 16nm



Source: Zhaoxin

The Company also announced its plan to introduce KX-7000/KH-40000 on TSMC's 7nm for its next generation product targeted in 2020-21. The current use case of the company's chipsets is being tested in the financial industry (PBoC, Shanghai Bank), Education (ShanghaiTech University) and Transportation (Shanghai MRT). However, to get complete technology control, the x86 architecture may still not be as suitable for China government.

Figure 41: Comparison of the technology development of the major China CPU fabless

China CPU fabless	Loongson	Phytium	Kunpeng	Sunway	Hygon	Zhaoxin
Shareholders	Institute of Computing Technology, Chinese Academy of Sciences	China Great Wall, CEC Group	Huawei	Wuxi Jiangnan Institute of Computing Technology	Sugon, AMD, Hygon	Shanghai Zhaoxin (VIA + Shanghai government)
Architecture	MIPS32	ARM v8	ARM v8	Sunway 64	x86	x86
PC	3A3000	FT2000/4	920s	SW410	7185	KX-6000
Tech spec	1.5GHz Quad core 64 bit	2.0GHz Quad core 64 bit	2.0GHz Quad / Octa 64 bit	1.6GHz Quad core 64 bit	2.0GHz 32 cores 64 bit	2.0GHz Quad core 64 bit
Manufacturing node	28nm	16nm	7nm	40nm	14nm	16nm
Server	3B3000	FT-2500/64	920	SW26010	7185	KH-30000
Spec	1.5GHz Quad core 64 bit	2.5GHz 64 cores 64 bit	2.5GHz 64 cores 64 bit	1.45GHz 260 cores 64 bit	2.0GHz 32 cores 64 bit	3.0GHz Octa cores 64 bit
Manufacturing node	28nm	16nm	7nm	28nm	14nm	16nm
IC design partner	NA	Alchip, EE2	HiSilicon	NA	AMD	VIA
Ecosystem support	Limited	Strong	Strong	Limited	Strong	Strong
Security	High	High	High	High	High	High
China technology control	High	Medium-High	Medium-High	High	Low	Low

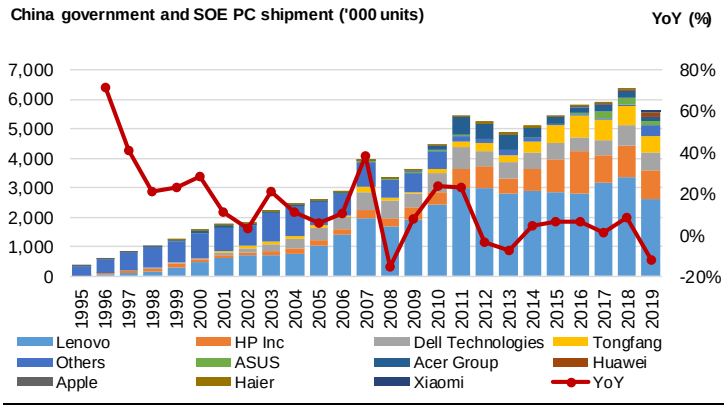
Source: Company data, Credit Suisse estimates

PC replacement demand from government and major enterprise to pick up from 2020

With the chipsets and operating system designed by local fabless being more mature and the growing urgency from China government to adopt the semiconductor that it has full control on, we believe the PC replacement demand will start picking up from 2020. According to IDC, the demand from China government and large enterprise market has been at 6 mn units annual run-rate in the past few years. Lenovo has been dominating at 45-50% market share, followed by HP (10%), and Dell (10%). We note that local brands have been picking up share in the government and large companies' procurement on which they have been testing the operating

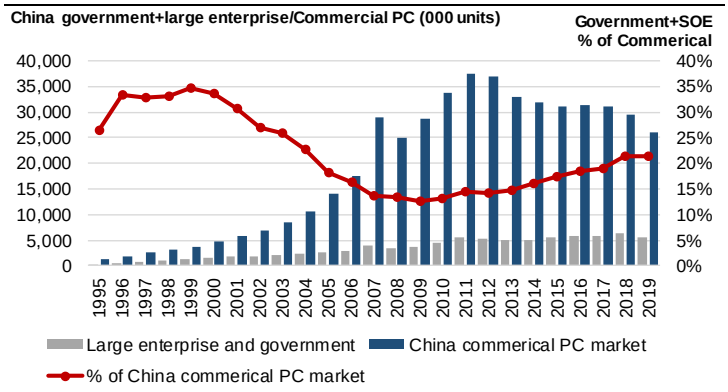
system since 2014, with Tongfang growing from 5% in 2013 to 10% in 2019, while other brands have also emerged from 0% to 3-4% in 2018-19.

Figure 42: China government and SOE PC shipment at 6 mn unit annual run-rate, with local brands gaining share



Source: IDC, Credit Suisse estimates

Figure 43: China government and SOE represents 20% of domestic commercial PC market



Source: IDC, Credit Suisse estimates

According to the China government statistics in the past few years, there are 7 mn civil servants in China and 30 mn employees in SOE, putting the total addressable market of the local CPU fabless at 37 mn units, and in the next few years, it could penetrate into the domestic commercial market at 25 mn annual shipment run-rate in the long term with encouragement from the government.

Phytium leading its local peers on technology roadmap and ecosystem

Among the major CPU fabless in China, Loongson has led the market, shipping 800k CPU in 2019, while Phytium also claimed to have built ~1 mn chipsets for shipment by the end of 2019. We believe Phytium (permanent license from ARM), Loongson (MIPS architecture) and Sunway (Alpha architecture) have better opportunities in the government and SOE market with a relatively higher technology control compared with Zhaoxin (x86 architecture), Hygon (the US entity list) and Kunpeng (banned by the US government along with Huawei, and focuses more on the commercial market).

Figure 44: **Phytium's PC CPU already gets qualification by local supply chain**

Source: Phytium

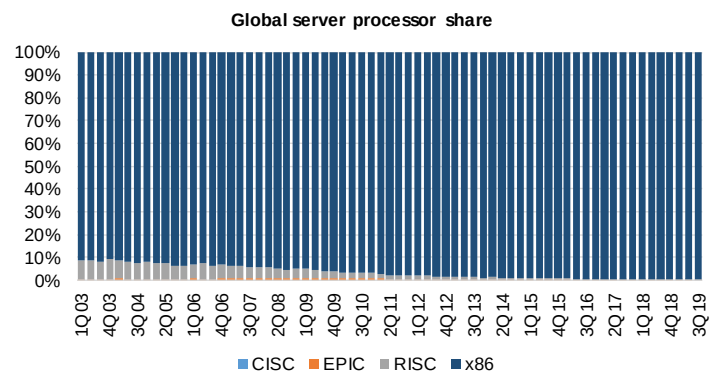
Compared with Loongson only migrating to SMIC's 12nm in 2020 and Sunway on 28nm, Phytium who is working with TSMC should see better performance and power consumption improvement on 16nm for the chipset launched in 2019 and the 7nm chipset in the roadmap for launch in 2022. Phytium also has the advantage over Loongson and Sunway in terms of the ecosystem support from ARM on documentation and essential task use for the civil servants and workers in SOE in China. ARM's architecture for PC/NB is also more mature now, with Qualcomm already having launched PC processor based on ARM core in 2018, while Apple will

also replace the Intel's x86 processor in its next generation Macbook. We believe Phytium's technology roadmap, support from Alchip in the back-end design, TSMC on the manufacturing in leading edge nodes and ARM on the ecosystem, and should benefit from the first wave of import substitution in the China PC market.

Server import substitution at a milder pace

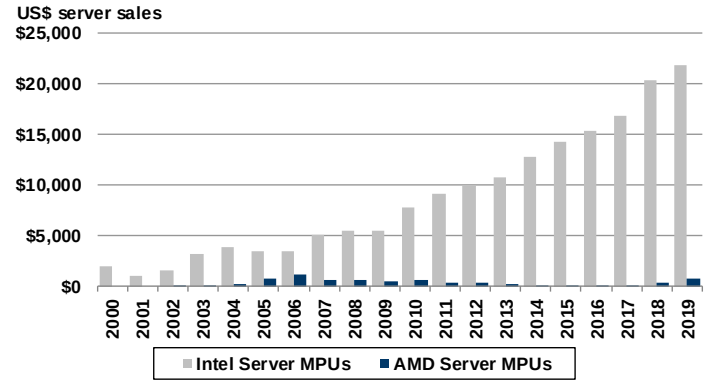
The server CPU market has long been dominated by x86 architecture in the past two decades, with Intel holding 95%+ market share, supported by the strong performance that its chipsets can deliver. We believe x86 architecture based processors will continue to be the mainstream solution for the server market in the next several years, with AMD gaining share at the expense of Intel. For China fabless development, although some chipsets have been introduced from Loongson, Phytium, Sunway, and Kunpeng, and the China government has also listed the solutions from these suppliers into its procurement directory in 2018, the adoption rate is still low as the performance, power consumption, and stability are still not comparable with the solutions provided by the overseas players.

Figure 45: Server CPU is still dominated by x86 (Intel + AMD)



Source: IDC, Credit Suisse estimates

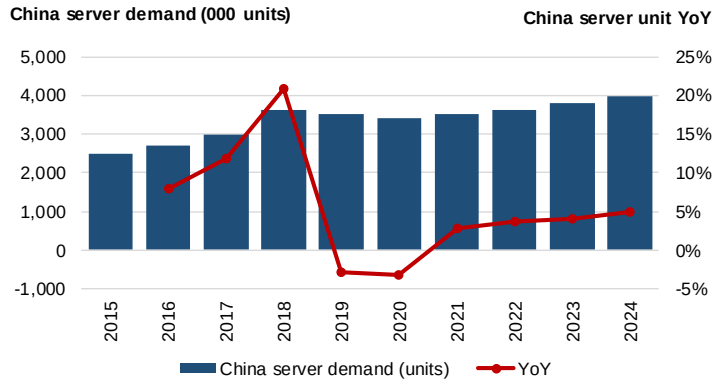
Figure 46: AMD has grown in the server market from a low base



Source: Company data, Credit Suisse estimates

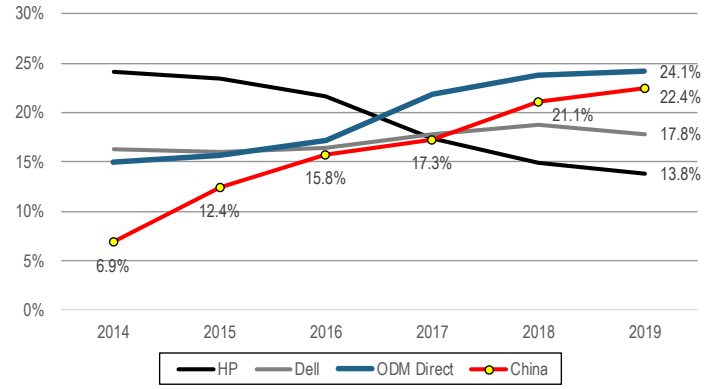
Chinese vendors' share in the global server market reached ~30% in 2019, mainly supported by their share gains in an outgrowing domestic market and modest growth outside China, mostly from Lenovo's acquisition of IBM's x86 business in 2015. We believe local suppliers' continued share gains in the China domestic market should continue to be the trend, supported by the government policy on high-technology applications with national security concerns.

Figure 47: China domestic server demand should reaccelerate



Source: IDC, Credit Suisse estimates

Figure 48: China players gain share with fast domestic growth



Source: IDC, Credit Suisse estimates

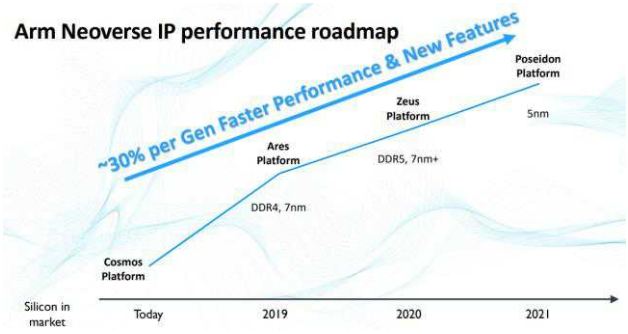
In the 'Made-In-China 2025' initiative, the China government disclosed plans to have its global market share for domestically produced high-performance computers/servers to reach 30%,

while the domestic market share to reach 60% by 2020, and the shares to reach 40% and 80% by 2025, respectively. It also aims to have domestically manufactured high-end servers to represent over 50% of the domestic market; and servers with domestically produced CPU to reach above 30% of the domestic market.

Despite, there is still a meaningful gap between x86 vs other architectures when comparing power performance and ecosystem, with most of leading local suppliers (e.g., Sugon and Inspur) still expecting to roll out new products along Intel's and AMD's roadmap for commercial use in 2020-21, we believe the servers shipped to government could be the first wave of demand, adopting CPUs developed by local fabless.

The noticeable development by China players recently would be that Kunpeng launched its Kunpeng 920 server CPU manufactured on TSMC's 7nm and adopted in Huawei's Taishan servers for Huawei's cloud platform, providing 30% higher performance or 20% less power consumption. Amazon earlier this year also introduced Graviton2 based on ARM Neoverse core for its AWS cloud service business. This could suggest that server processor based on ARM architecture could be adopted for commercial use following the company's aggressive push on the server addressable market in the past 6-7 years.

Figure 49: ARM's Neoverse IP has improved its competitiveness in the server market



Source: ARM

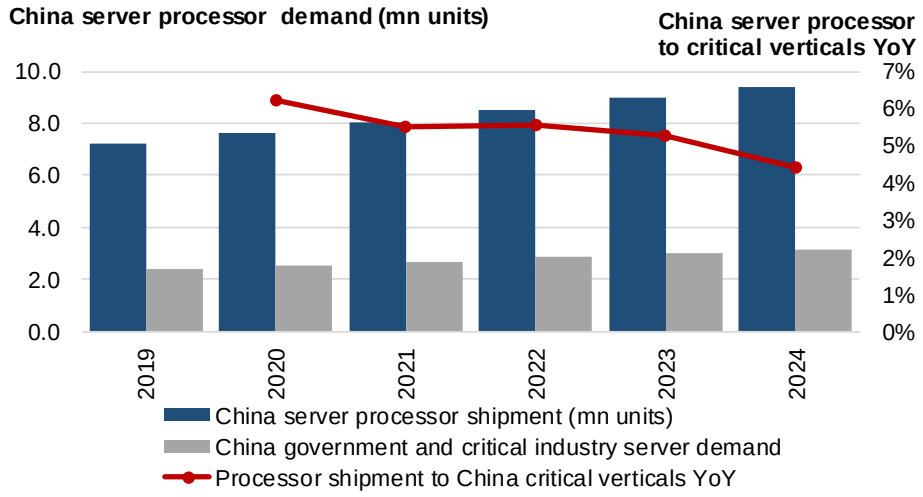
Although the performance still needs time to be proven, we believe it could be a positive signal for Phytium, as the company has also been developing server CPU for 7 years, with first generation FT-1500 launched in 2014, FT-2000 in 2016, and an upgraded version FT-2000+ tape-out in 2017. The company targets to launch FT-2500/64 chipset on 7nm for server market in 2H20. At the company's ecosystem conference in late 2019, multiple partners announced to build data centre based on Phytium's 64 core CPU solutions, including financial and network security. For the commercial market, Tencent Cloud also announced to introduce a platform based on Phytium's CPU, while Baidu also announced to build solution integrating Phytium's CPU with its cloud AI chipset Kunlun.

Figure 50: Phytium's server CPU has domestic support from hardware to software

Source: Phytium

Based on our estimate, the government server demand in China could represent 20-30% of total shipment in the domestic market, implying 600k server unit annual run-rate opportunity for local server suppliers. According to IDC, the global server processor demand will grow from 27 mn units in 2019 to 36 mn units in 2024. With China representing 25-30% of global server market and demand from local government and data sensitive industries (e.g., telecom and finance) representing 30-35% of domestic demand, we estimate the server processor market could grow to 3 mn units for local fabless to capture the first wave of demand.

Figure 51: China's server demand from government and SOE should be the second wave application of China CPU fabless penetration

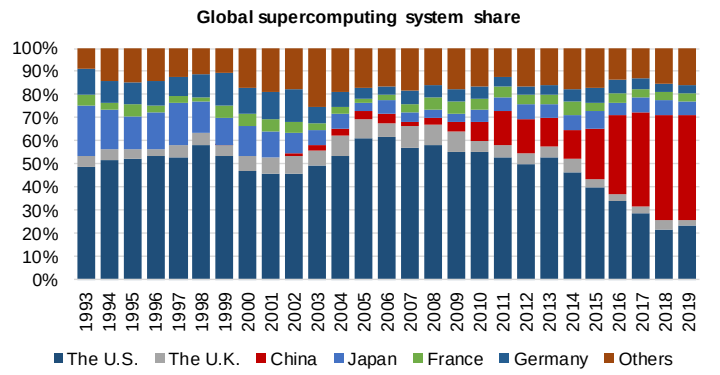


Source: IDC, Credit Suisse estimates

China fabless making progress on supercomputing

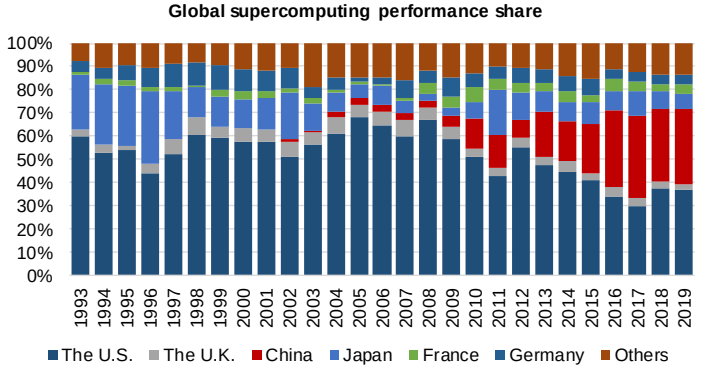
Although China has been fast developing its super computing system for scientific use, with its unit share among the global top 500 supercomputing system, from 0% in 2000, 8% in 2010, to 46% in late 2019, but most of the critical semiconductor components still rely on Intel for CPU and AMD/Nvidia for accelerator. However, since 2015, the US government has stopped Intel from shipping its Xeon products to Chinese supercomputing institutions due to concerns about their use in nuclear tests. Since the restriction, China has been gaining in the supercomputing system share but the computing share has been unchanged, suggesting limited system level performance improvement compared with its overseas peers.

Figure 52: China continues to grow system share



Source: Top500,org, Credit Suisse

Figure 53: China's performance share has been stagnating

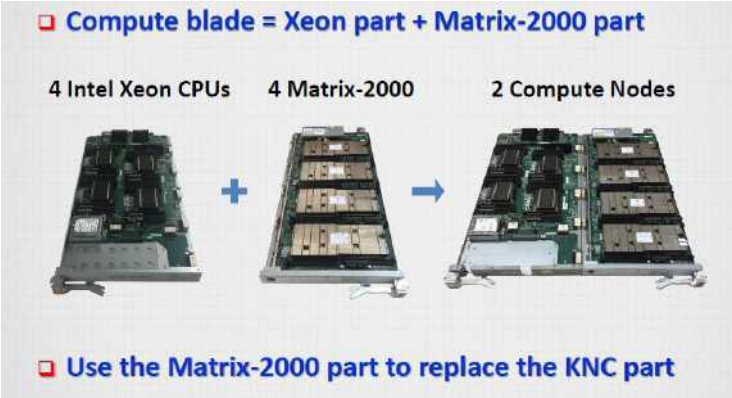


Source: Top500.org, Credit Suisse

To replace solutions provided by overseas suppliers, China local institutions have been working on developing their own supercomputing CPU and accelerator based on different architecture

since 2015, with three major ones including Loongson (MIPS), Sunway (ALPHA) and Phytium (ARM).

Figure 54: Tianhe-2A replaced Intel Xeon PHY with its own Matrix-2000 accelerator


Compute blade = Xeon part + Matrix-2000 part
4 Intel Xeon CPUs
4 Matrix-2000
2 Compute Nodes
Use the Matrix-2000 part to replace the KNC part

Source: Tianhe-2A

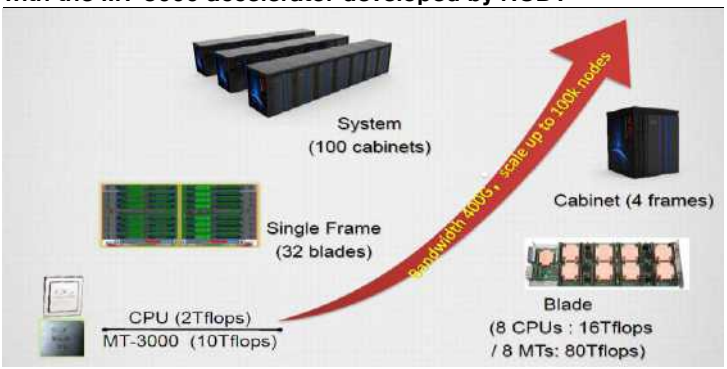
The China National University of Defense and Technology developed Matrix-2000 accelerator on 28nm which replaced Intel's Xen PHY chipset, and along with Phytium's FT-2000 CPU, some computing nodes were deployed in Tianhe-2A supercomputing system in the National Supercomputing Center of Guangzhou in 2017.

The institution subsequently developed Matrix-2000+ accelerator on 16nm in 2017 for the Tianhe-3 prototype. The company has also long been adopting the network interconnect it developed in the Tianhe supercomputer in 2012. With a strong relationship with NUDT, Phytium's FT-2000+/64 processor was also adopted in some nodes in the Tianhe-3 prototype. Based on the schedule, the Tianhe-3 supercomputer should be introduced in late 2020, and with adoption of Phytium's FT-2500/64 CPU and NUDT's MX-3000 accelerator.

Figure 55: Supercomputing migrating to exascale computing power

Source: UNSW

Figure 56: Tianhe-3 could adopt Phytium's FT-3000 CPU along with the MT-3000 accelerator developed by NUDT



Source: Tianhe-3

A high potential for the IC design service companies

Among the major CPU fabless in China, Loongson has led the market, shipping 800k CPU in 2019, while Phytium also claimed that it built ~1 mn chipsets for shipment by the end of 2019. We believe Phytium (permanent license from ARM), Loongson (MIPS architecture), and Sunway (Alpha architecture) have better opportunities in the government and SOE market with a relatively higher technology control, compared with Zhaoxin (x86 architecture), Hygon (the U.S. entity list) and Kunpeng (banned by the US government along with Huawei, and focus more on the commercial market).

For the Taiwan IC design service industry to capture China's CPU import substitution for government and critical verticals, we believe the best proxy would be Alchip, with the company's

strong relationship with Phytium. Alchip also has a long-term partnership with local high performance computing customers on networking chipsets and CPU design. On the other hand, Global Unichip has been more conservative on participating in government related business, so would see limited benefit from China import substitution demand.

Figure 57: IC design service has US$40-50 content per PC CPU on 16nm and US$150 per server CPU on 7nm for China fabless

	PC	Server
Die size	230	370
Manufacturing node	**16nm**	**7nm**
Total wafer area	70,650	70,650
Usable area	85%	85%
Yield	90%	85%
Chip on wafer	**235**	**138**
Wafer price (US$)	$5,625	$11,250
Wafer cost per chip	$24	$82
Mask cost/chip	**$3**	**$13**
Front + Back-end cost	**$32**	**$109**
Total COGs for IC design service (US$)	**$34**	**$121**
Turnkey GMs for IC design service	**18%**	**20%**
Chipset price to the customers (US$)	**$42**	**$152**

Source: Credit Suisse estimates

Although the procurement will still be allocated among Phytium, Loongson, Hygon, Zhaoxin, and Kunpeng, we try to calculate the potential for Alchip, if Phytium captures the majority of the share with its leadership in the technology migration (PC CPU on 16nm in 2019 and server CPU on 7nm in 2020) and product roadmap. At 6 mn PC CPU and 3 mn server CPU annual demand for Phytium and Alchip's requirement, respectively, for 15-20% GMs for turnkey business, the company's addressable market in China CPU could expand to ~US$720 mn per annum (US$200 mn from PC CPU and US$450 mn from server CPU) in the next few years.

Figure 58: Alchip's addressable market for China PC/NB and server CPU and supercomputing could reach US$780 mn

Alchip's turnkey business	2019	2020	2021	2022	LT addressable market
China PC CPU shipment (000 units)	400	1,800	2,100	3,000	6,000
China PC CPU ASP from Alchip (US$)	$45	$45	$45	$45	$45
China server CPU shipment (000 units)	0	10	50	150	3,000
China server CPU ASP from Alchip (US$)	$150	$150	$150	$150	$150
China CPU sales contribution	**$18**	**$83**	**$102**	**$158**	**$720**
Supercomputing sales contribution	**$0**	**$7**	**$43**	**$25**	**$60**
China CPU + supercomputing contribution (US$mn)	**$18**	**$90**	**$145**	**$183**	**$780**
Alchip's sales (US$mn)	**$144**	**$224**	**$289**	**$329**	
% of Alchip's sales	**12%**	**40%**	**50%**	**56%**	

Source: Credit Suisse estimates

In addition to the China CPU opportunity, the company has China supercomputing system exposure to network interconnect projects. We estimate the content per system is US$30-40 mn on 16nm and should grow to US$50-60 mn for a 7nm project, further expanding its addressable market.

Figure 59: Supercomputing could represent another opportunity for Alchip

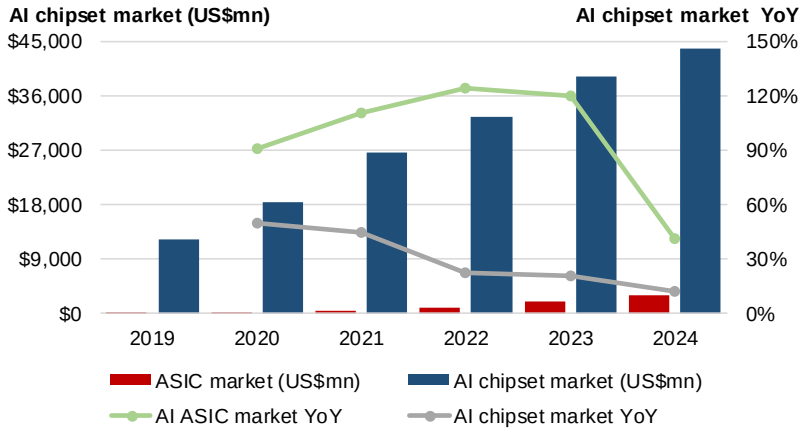
Supercomputing opportunity	2017	2018	2019	2020	2021	2022
China	$35	$0	$0	$7	$43	$25
Japan	$30	$0	$0	$0	$0	$0
Supercomputing sales	**$65**	**$0**	**$0**	**$7**	**$43**	**$25**
Alchip's sales (US$mn)	**$142**	**$115**	**$144**	**$224**	**$289**	**$329**
% of Alchip's sales	**46%**	**0%**	**0%**	**3%**	**15%**	**8%**

Source: Credit Suisse estimates

Growing AI computing drives ASIC demand

AI has been showing more impact in the past few years across the enterprise and end consumer market, with most notable areas seeing the change from AI implementation, including manufacturing, finance, education, transportation, and new emerging concepts including smart city, smart home and smart healthcare. The AI innovation is supported by more mature technology ecosystem across hardware (chip and sensors), software (framework) and service (cloud computing and data collection). According to IDC, the AI market is likely to grow from US$28 bn in 2018 to US$98 bn in 2023E at a CAGR of 29%, supported by the use cases across healthcare, financing, robotics, transportation, retail, education, security and manufacturing.

Figure 60: AI ASIC is likely to outgrow the AI semiconductor market

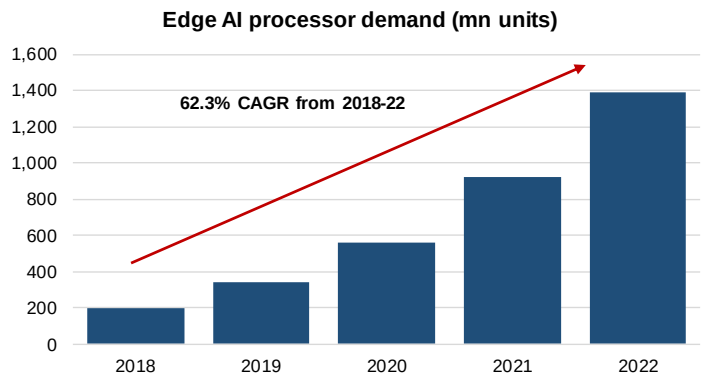


Source: Gartner, Credit Suisse estimates

AI semiconductor market should grow along with rising penetration

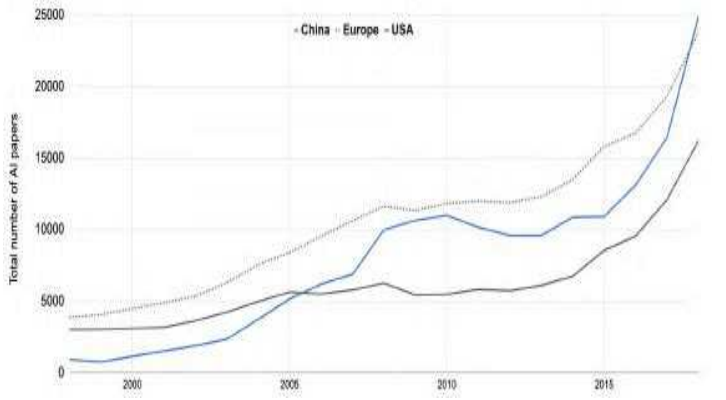
Along with the development and investment in AI, the semiconductor industry is also evolving beyond the traditional CPU powered computing ecosystem. Gartner expects global AI semiconductor revenue to grow from US$12.3 bn in 2019 to US$43.9 bn in 2024E at a CAGR of 29%, with key drivers from the main processor, digital signal processor (DSP), GPU and FPGA. Based on IDC's estimate, global AI edge processing unit will grow from 20 0mn units in 2018 to 1.4 bn in 2022 at a CAGR of 62%.

Figure 61: Edge AI processor is projected to reach 1.4 bn in '22



Source: IDC, Credit Suisse estimates

Figure 62: AI related patents have been surging since 2015



Source: Stanford University

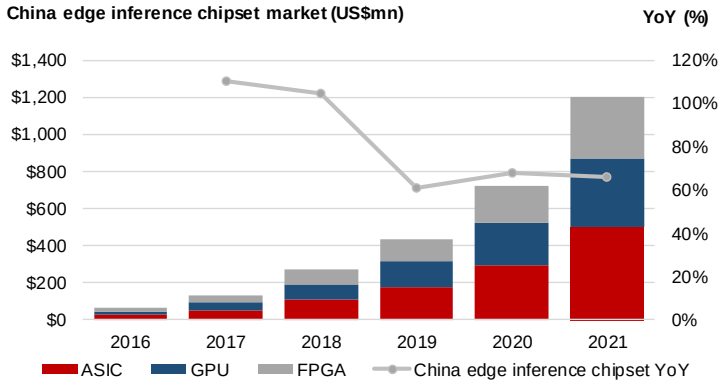
China AI processor market has high growth potential for both cloud and edge

For China specifically, the government is supporting the local semiconductor ecosystem. Most of the fabless and chip start-ups see AI chipsets as a good entry to compete with their overseas peers as the AI development in China has been fast, while these fabless already lag their global peers in other mature semiconductor market (PC and mobile).

Figure 63: China AI chipset demand is also seeing fast growth

Source: CCID, Credit Suisse estimates

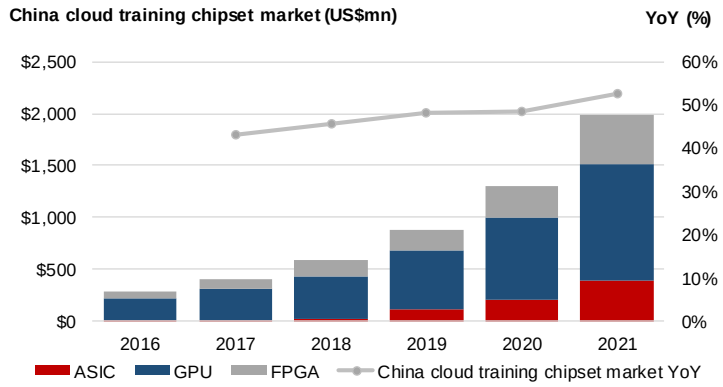
Figure 64: ASIC will play an important role for AI inference



Source: CCID, Credit Suisse estimates

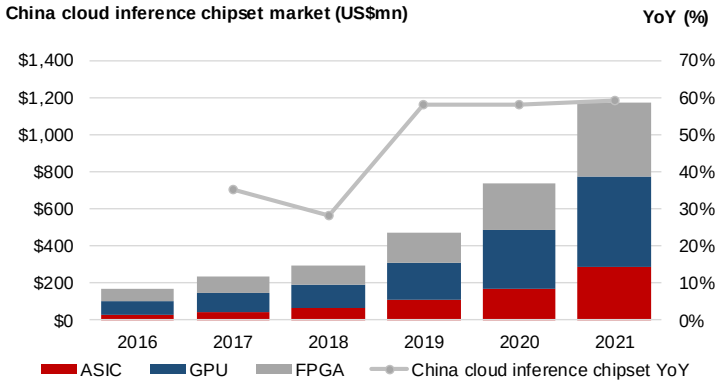
The trend should support a fast growing AI semiconductor in China. Based on CCID's estimates, China AI chipset industry has grown from US$500 mn in 2016 to US$1.2 bn in 2018, and it expects the market to grow to US$4.3 bn by 2021.

Figure 65: GPU and FPGA may still dominate AI cloud training



Source: CCID, Credit Suisse estimates

Figure 66: AI cloud inference will see more ASIC adoption



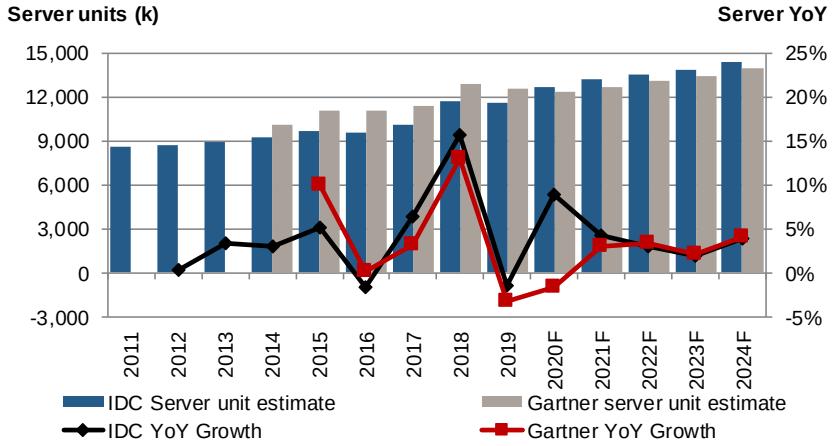
Source: CCID, Credit Suisse estimates

By purpose, cloud training chipset represented the majority of the market at 51% in 2018 at US$600 mn, followed by cloud inferencing (US$300 mn), and endpoint inferencing (US$300 mn). CCID estimates China cloud training, cloud inferencing and endpoint inferencing chipset market to grow to US$2 bn, US$1.2 bn, and US$1.2bn, respectively, by 2021. By chipset type, ASIC will grow in importance, representing 27% of the China AI chipset market in 2021 (vs 23% in 2019), while GPU will decline from 50% in 2019 to 45% in 2021, and FPGA will be relatively stable at 27-28%.

Diversified and growing data centre applications also drive ASIC demand

The US and China hyperscale cloud service providers and Internet companies continue to drive the data centre spending market. The overall unit projections for the server market are for a relatively modest unit growth. IDC and Gartner diverge on 2020 growth, with IDC +8% and Gartner -2%, but both servers forecast a moderation to 2-4% unit growth from 2022-24.

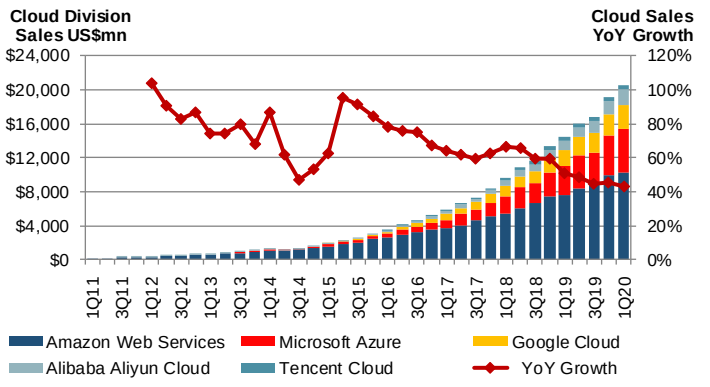
Figure 67: IDC/Gartner project server units at low-single digits growth



Source: IDC, Gartner

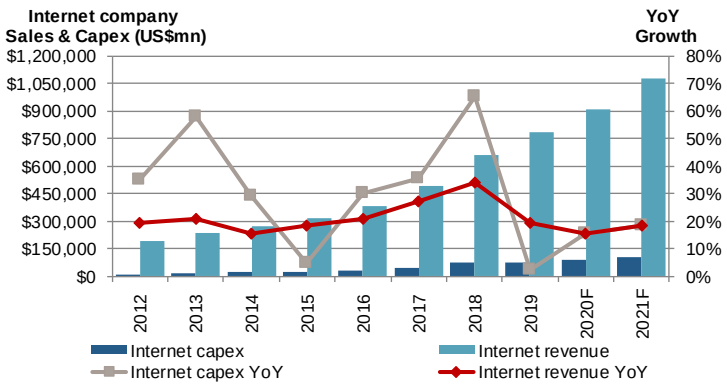
Relative to those modest market growth estimates for the overall server market, which includes mature enterprises, the growth in cloud and Internet service revenue points to faster potential growth for that tier of the market. The cloud growth at the top operators, Microsoft, Amazon,

Figure 68: Cloud service growth >40% supports spending



Source: IDC

Figure 69: Internet service growth supports continued capex



Source: Gartner

Google, and Alibaba, remain over 40% YoY through 1Q20. Revenue growth for these companies' overall businesses, which include social networking, gaming and e-commerce portions remain healthy, projected to grow +16% YoY to US$911 bn in 2020 and a further +19% YoY to US$1.08 tn in 2021. The strong growth in their own service plus hosted cloud workload should require a high level of spends continuing from these channels.

ASIC gaining more traction for AI computing as Moore's Law slows

There are different types of AI chipsets, with four major segments, including CPU, GPU, FPGA and ASIC. General-purpose chips like CPUs can be used for some simpler AI tasks. Traditionally, CPU has been dominating the computing tasks over other chipsets as its performance can benefit from fast node migration with high volume demand, supporting it to outperform other chipsets lacking economies of scale despite their better algorithm to run dedicated tasks. However, with the slowing Moore's Law in the past few years, the efficiency improvement for CPU has been much slower compared with other AI chips with higher flexibility on design for performance optimisation. Therefore, GPU, FGPA, and ASIC have been gradually replacing CPU as more suitable options for AI to run dedicated tasks and calculations in parallel (vs sequential in CPU).

Figure 70: **Different types of chipset comparison for AI computing**

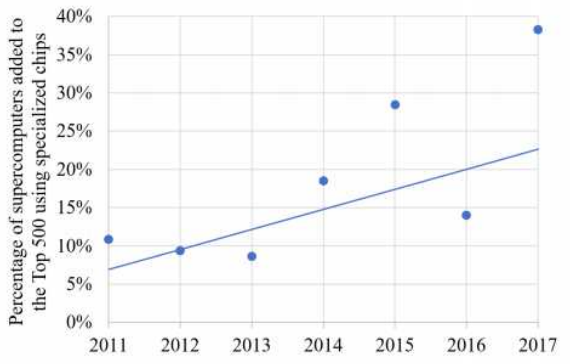
	CPU	GPU	FPGA	ASIC
Processing peak power	Moderate	High	Very high	Highest
Power consumption	High	Very high	Very low	Low
Flexibility	Highest	Medium	Very high	Lowest
Training	Low	Moderate	Low-moderate	High
Inference	Low	Moderate	High	High
Cost per compute	High	High	Moderate	Low
Major applications	General computing	Cloud training Cloud inference	Cloud inference Edge inference	Cloud training Cloud inference Edge inference
Companies	Intel, AMD	Nvidia, AMD	Xilinx, Altera	Diversified

Source: Credit Suisse estimates

For the current AI chipsets, they have their own advantage when it comes to different tasks, with GPUs mostly used for AI training (algorithm development and refinement), FPGAs used for inference (applying trained algorithms to data inputs), while ASICs used for either training or inference. We highlight the key difference between GPU, FPGA and ASIC as below.

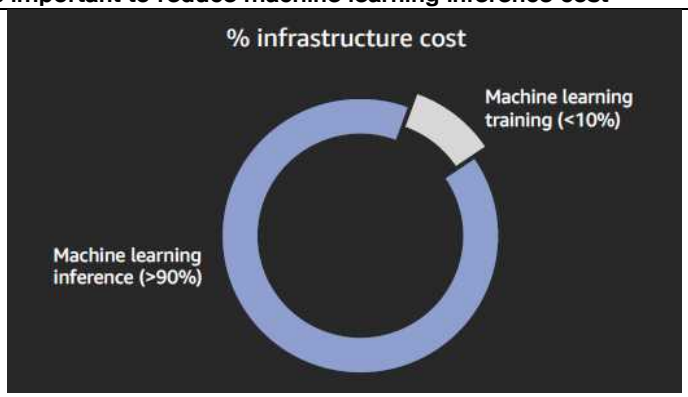
- **GPU (Graphic Processing Unit):** Graphic could be used for training as they offer the wide floating point computational power and wide memory buses, allowing quick data movement for storage and intermediate data needed for training. Although it could be used for training, the adoption of GPU for AI inference is not that suitable as inference does not need faster memory transfers and high precision calculations, especially for edge inference. Some of the performance could also be wasted as GPUs are designed primarily for graphics processing. The market is dominated by Nvidia and AMD.
- **FPGA (Field Programmable Gate Arrays):** FPGAs has an advantage on high flexibility, low latency, and lower power consumption compared with GPU and CPU, it can run the tasks in parallel. The difficulty to use FPGA in AI is that FPGAs tend to run slow and burn a lot of power, if not partitioned and designed correctly. The market is dominated by Xilinx and Altera.

Figure 71: ASIC gets importance in supercomputing now



Source: Stanford University

Figure 72: Amazon sees that more efficient chipset computing is important to reduce machine learning inference cost



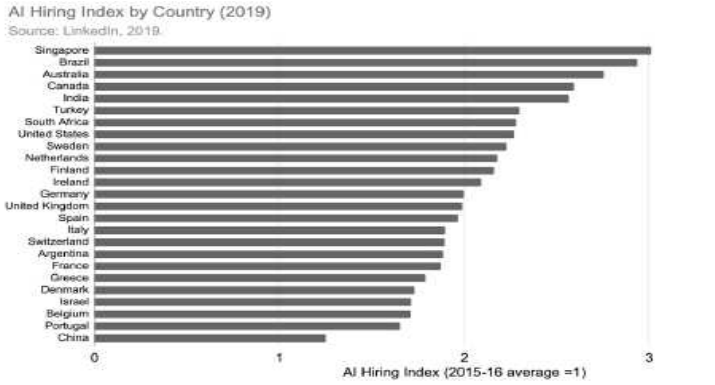
Source: Amazon

- **ASIC (Application-Specific Integrated Circuit):** An ASIC is custom designed chipset for dedicated tasks, providing high flexibility for the end users to add additional features (e.g., extra ports, enhanced security), while limiting the overheads compared with CPU, GPU and FPGA. Due to high customisation, the ASIC industry is fragmented, with players including major internet companies developing chipsets for their own systems or start-ups providing solutions for certain applications. According to MIT, in addition to enterprise and end market, the ASIC is also more widely adopted in supercomputing systems, with % of ASIC adoption in global top 500 supercomputers growing from 10% in 2011 to 40% in 2017, to enhance the computing power in addition to the existing CPUs.

AI investment has been accelerating since 2014

According to Stanford University's 'The AI Index 2019 Annual Report', the accelerating AI development has triggered the AI papers published at a much faster pace since 2015 vs the levels in 2000-15, with China seeing the largest growth. The growing AI applications and services have also driven the demand for AI talents. According to Stanford University's AI Hiring Index, most of the countries have witnessed at least doubling demand for AI talents in 2019 compared with the levels in 2015-16. To facilitate the AI progress, the investment made by enterprises and capital (PE and VC) has also grown meaningfully to ~US$90 bn in 2019.

Figure 73: AI hiring in general has been increasing 2-3x in the past few years



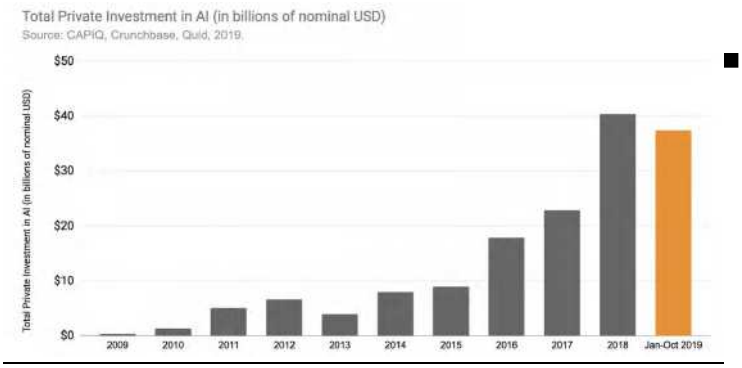
Source: Stanford University, *China and India may not fully reflected with limited LinkedIn coverage

Figure 74: Investment in AI is also surging through VC investment, IPO and M&As

Source: Stanford University, *data for 2019 through October

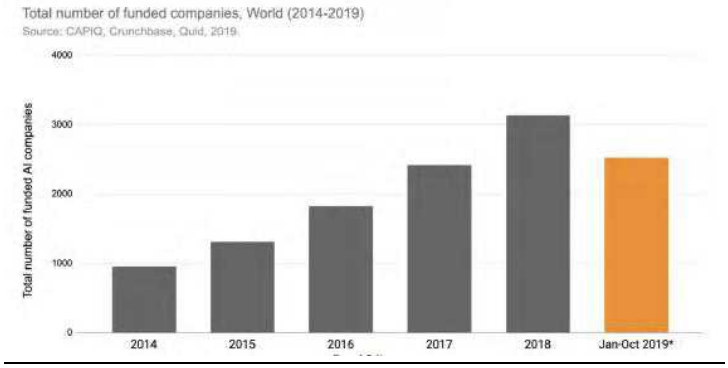
For the AI start-ups, Stanford University estimates the capital they raised has also been increasing from US$1.3 bn in 2010 to ~US$40 bn in 2018 at a CAGR of 48% from 2010-18, and each of these start-ups on average have received US$8.6 mn funding between 2014-18.

Figure 75: AI investment in start-ups has risen meaningfully since 2016



Source: Stanford University

Figure 76: The higher AI investment also drives the start-up boom in the past few years

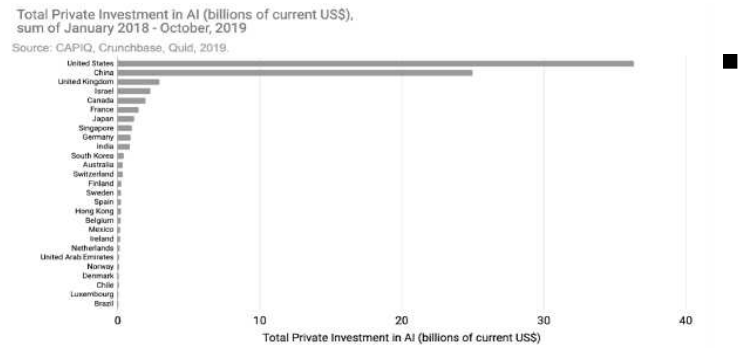


Source: Stanford University

5% of AI start-up investments are in semiconductors

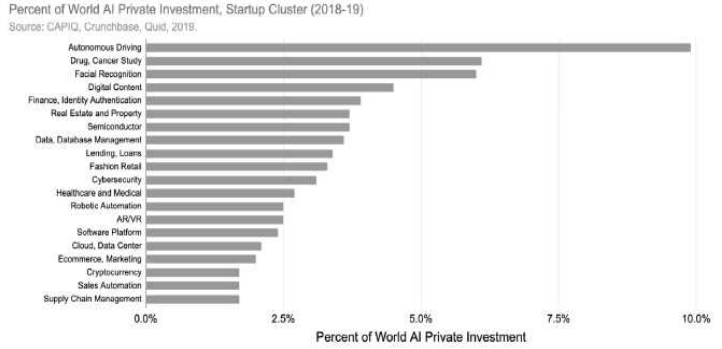
The private investment on AI start-ups is led by the US and China, representing ~45% and ~30% of total investment made from 2018-19, respectively. According to the Stanford University, the most popular areas AI start-ups have been investing in the past two years include autonomous driving (10% of total investment), drug and cancer study (6.5%), facial recognition (6.5%), digital content (4.6%), finance (4%), real estate (3.8%), and semiconductor (3.8%). Based on 3.8% investment in semiconductor out of a total ~US$90 bn capital injected in AI start-ups in 2018-19, we note that it would represent US$3.5 bn investment in semiconductor chipsets by global AI start-ups.

Figure 77: Most of the AI investment are in the US and China, representing 75-80% of total funding



Source: Stanford University

Figure 78: Autonomous driving, drug research, and facial recognition are most popular among AI investments



Source: Stanford University

For China, the investment in algorithm, computing system and semiconductor technology reached US$3 bn from 2014-19, representing 5.6% of total US$51 bn investment made in China AI start-ups during the period, according to ChinaVenture Institution. At 5-6% of total AI investment, we expect the investment in AI semiconductor to continue to grow.

TSMC leads in AI projects in the advanced nodes

We highlight major AI chip start-ups, with most of the projects spanning from core to edge computing for AI training, inference and other applications.

Figure 79: Most of the AI semiconductor projects are on advanced nodes, with TSMC as the key foundry beneficiary

Start-ups	Key focus area	Country	Foundry	Most advanced node	Tech investors
AIMotive	Semiconductor chipset and software for automated driving	Hungary	GlobalFoundries	22nm FD-SOI	Cisco, Samsung
Blaize	Vision processing chips	US	TSMC	28nm HPC	Denso, Samsung
BrainChip	Neuromorphic SoC (Akida) that can be function as an SoC or integrated into ASIC	Australia	TSMC	28nm	Listed
Cambricon	Device and cloud processors for AI	China	TSMC	7nm	Alibaba, TCL
Cerebras	Systems Specialized chip for deep-learning applications	US	TSMC	16nm	NA
Deep Vision	Low-power silicon architecture for computer vision	US	TSMC	28nm HPC	NA
DeepcreatIC	Heterogeneous neuromorphic chips	China	SMIC	40nm	NA
Deephi	Compressed CNN networks and processors	China	TSMC	7nm	Xilinx
DinoPlus	High-performance and ultra-low latency AI chipsets for 5G/edge computing	US	NM	NM	NA
Enflame	Cloud-based deep learning chips for AI training platforms	China	GlobalFoundries	12nm LP	Tencent, SummiView
Esperanto	Massive array of RISC-V cores	US	TSMC	7nm	Western Digital
GrAI Matter Labs	AI chipsets designed for ultra-low latency and low power processing at the edge	France	TSMC	28nm	NA
Graphcore	Graph-oriented processors for deep learning	UK	TSMC	16nm	Dell
Groq	Google spinout working on deep learning chip	US	NM	14nm	NA
Habana Labs	Programmable deep learning accelerators for data center training and inference	Israel	TSMC	7nm	Intel
Hailo	Specialized deep learning microprocessor	Israel	NM	NM	NEC
Horizon Robotics	Chipsets and solutions for smart Home, automotive and public safety	China	TSMC	16nm	SK Hynix
IntelliGo	Hardware and software for image and speech processing	China	NM	NM	Mediatek
Intengine Tech	AI chips for embedded system for edge computing	China	NM	NM	NA
Kneron	NPU that accelerates neural network models making possible applications (e.g. face detection and gesture control) in embedded devices	US	TSMC	16nm	Alibaba, Himax, Qualcomm
Lightmatter	Programmable photonic to accelerate critical operations in deep neural networks	US	NM	NM	Alphabet
Lynxi	Brain-like computing chip for high performance computing	China	NM	28nm	NA
Mythic	Ultra-low power neural networking inference chips based on flash+analog+digital	US	Fujitsu	40nm	Lam Research, Micron, Softbank
Novumind	AI for IoT	US	TSMC	7nm	NA
Preferred Networks	Real time data analytics and chipset solutions with deep learning library	Japan	TSMC	12nm	Hitachi, Fanuc
Reduced Energy Microsystems	Chipset solutions for deep learning and machine vision with low power consumption	US	GlobalFoundries	22nm FD-SOI	NA
SambaNova	Reconfigurable Array platform for matrix arithmetic for AI applications	US	NM	NM	Google, Intel
SenseTime	Chipset solutions for computer vision	China	NM	NM	Softbank, Singtel, Qualcomm, Alibaba
SiMA.ai	Machine Learning SoC platform for high performance and low power consumption	US	NM	NM	Dell
Syntiant	Customized analog neural networks	US	NM	40nm ULP	Amazon, Microsoft, Intel
Tenstorrent	Deep learning processor for faster training and adaptability to future algorithms	Canada	GlobalFoundries	12nm	NA
Thinkforce	AI chips for edge computing	China	NM	NM	NA
Tsinghua Thinker	Low power AI chips for edge computing	China	TSMC	65nm LP	Tsinghua VC
Unisound	Chipsets for AI-based speech and text capability	China	TSMC	28nm	Qihoo
Vathys	Chipset design for deep learning supercomputers	US	NM	NM	NA
Wave Computing	ASIC solutions for deep learning computers	US	TSMC	7nm	Samsung
Xanadu	Quantum photonic processors	Canada	NM	NM	NA

Source: Company data, Credit Suisse estimates

With its strong OIP ecosystem and technology roadmap, TSMC is partnering with 17 out of the 23 AI start-ups, outperforming its foundry peers (e.g., Samsung and GlobalFoundries). Most of

the projects that the start-ups are working with TSMC in terms of current products are on 16/12nm and with plans to migrate to more advanced nodes to gain performance and improve power consumption.

We also list the start-ups with support from major tech companies, as these companies tend to have better opportunities to turn into high volume customers for foundries, if they can deliver their technology roadmap, with examples including Deephi acquired by Xilinx and Habana acquired by Intel.

In addition to the growing AI start-ups ecosystem, we provide the details on the recent progress made by major internet and semiconductor companies on AI chip development. We would note the US internet companies in the past few years have been more aggressive on building their optimised solutions for their own and customers' use.

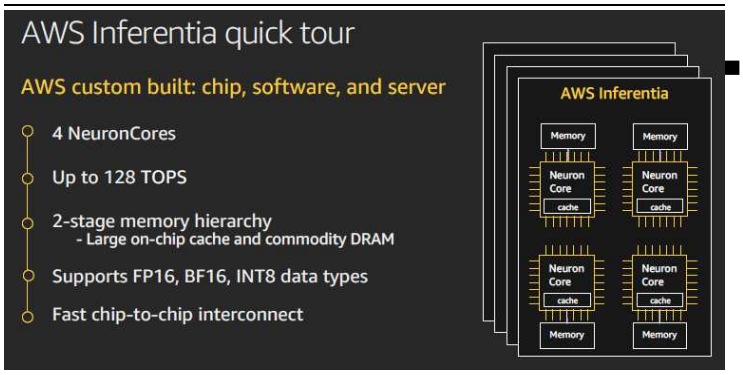
Figure 80: Internet companies are also more aggressive investing in AI chipsets

Company	Project	Foundry	Manufacturing node
Alibaba	Hanguang 800 / 900	TSMC	12nm / 7nm
Amazon	Inferentia / Graviton / Graviton 2	TSMC	16nm / 16nm / 7nm
Baidu	Kunlun	Samsung	14nm
Google	TPU v1 / v2 / v3	TSMC	28nm / 20nm / 16nm
Intel	Goya / Gaudi - with Habana	TSMC	16nm / 16nm
Microsoft	Graphcore's IPU	TSMC	16nm
Qualcomm	Cloud AI 100	TSMC	7nm
Tencent	Started chipset design business in March		

Source: Company data, Credit Suisse estimates

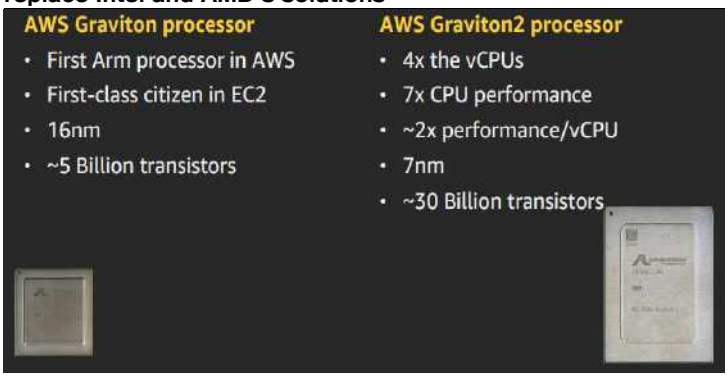
Amazon in 2018 introduced the Inferentia chipset for machine learning inference, while it launched ARM based Graviton solutions as a substitutes for Intel and AMD's x86 server CPU solutions, with majority of its processors manufactured on TSMC's advanced nodes. Google also developed TPU as the accelerator to improve the computing efficiency also on TSMC's 16/12nm node for the latest TPU v3.

Figure 81: Amazon highlighted its Inferentia chipset for AI inference



Source: Amazon

Figure 82: Amazon also plans to use its Graviton processor to replace Intel and AMD's solutions



Source: Amazon

Amid growing trade tensions and the need to improve performance and lower power consumption, China internet companies have also been expanding their chipset design capabilities recently. Alibaba set up T-Head as its IC design business and has already developed Hanguang 800/900 series chipsets for AI inference on TSMC's 12nm and 7nm, respectively. Baidu who is working with Samsung also has its Kunlun chipset for both edge and cloud AI computing. Tencent in March started its fabless subsidiary to catch up on the semiconductor learning curve.

With AI training and inferencing taking a lot of time and cost, it is important not only the algorithm and design of the chipset to be optimised to run these tasks, but also critical to use the most advanced manufacturing technology for further performance improvement and lower power consumption. For TSMC, we believe the high share in both start-ups and system

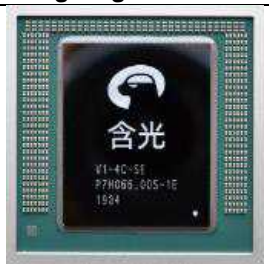
companies shows the company's strong technology capability, and should support it to capture the opportunity in the fast growing AI market.

Figure 83: Baidu's Kunlun AI computing chipset is manufactured on Samsung's 14nm

Baidu Kunlun AI chipset spec
Samsung's 14nm
PCIE 4.0
32GB/s support
2.5D packaging
250Tops computing power
150W power consumption

Source: Baidu

Figure 84: Alibaba's IC design subsidiary T-Head launched its AI inference chipset Hanguang 800 on TSMC's 12nm

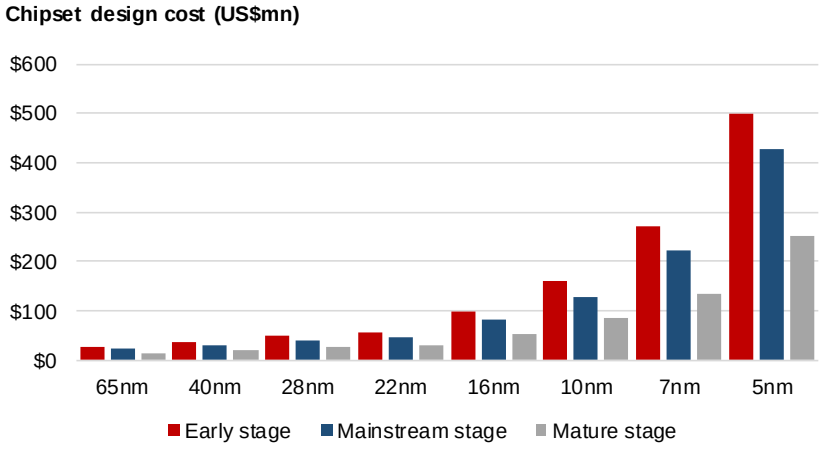


Source: T-Head

However, the chipset design is also getting more expensive in the advanced nodes, with cost surging from US$28.5 mn on 65nm to US$51.3 mn on 28nm and US$542.2 mn on 5nm in the early stage, according to IBS Research. The capital requirement is still high even if the node is more mature, with chipset development cost on 5nm still at US$250 mn, almost double the cost on 7nm.

It is especially challenging for the start-ups who in general lack sufficient funding support. For the major enterprises, the investment on the advanced semiconductor projects is also meaningful so it is important for them to ensure the success of chipset tape-out, high production yield and fast time-to-market. Therefore, it gives the IC design service companies opportunity to serve the start-ups and system companies who don't have sufficient IC design capability and experience.

Figure 85: IC design cost surges in the advanced nodes



Source: IBS Research, Credit Suisse estimates

Among Taiwan IC design service providers, we believe Global Unichip and Alchip are the two key beneficiaries of the growing AI industry. Both these companies should be able to leverage their strong track record on the back-end design, support in the advanced nodes, and relationship with TSMC to secure sufficient capacity for their customers. With the AI ASIC market still fragmented, with a diversified customer base (established players + start-ups) and a wide range of applications and verticals, we expect the wafer volume per project to be milder compared with mainstream and standardised chipsets, limiting the risk for these customers to go to foundries directly as their volume gets bigger. We highlight the key progress for Global Unichip and Alchip in AI semiconductor market as below.

Initiate coverage on Alchip and Global Unichip

We initiate coverage on Alchip and GUC. We believe Taiwan IC design service companies with higher high performance computing exposure and capacity support in the advanced node should benefit from the diversifying computing opportunity from the concentrated CPU, GPU and FPGA market to a broad customer base for ASIC start-up and system house for the applications including AI, 5G and other applications requiring fats computing. For Alchip, we believe the company has additional growth driver from China CPU substitution, with its key customer Phytium leading in the market, while the company also has exposure in supercomputing system. We rate Alchip an OUTPERFORM with TP of NT$630.00 (31% upside); and GUC a NEUTRAL with TP of NT$250.00.

Alchip (3661.TW, OUTPERFORM, TP NT$630)

We initiate coverage on Alchip with an OUTPERFORM rating with TP of NT$630.00. Alchip is a IC design service company based in Taiwan with a strong R&D team in China, with a focus on projects including HPC and AI on the advanced nodes. The company's sales saw a meaningful growth in 2019 supported by China CPU ramp for PC adopted by the local governments and SOE and tape-out of the AI project. We believe the company's sales should see a 30% CAGR from 2019-22E on growing China CPU demand in PC and server, growing content in the supercomputing system on 7nm for its China customer and more HPC and AI projects from its China and US start-up and system company customers.

On growing China CPU and AI market opportunity, we model the company's EPS at NT$15.50/NT$21.00 in 2020/21E. Our target price of NT$630.00 is based on 30x of 2021E P/E, at the upper half of its range 10-30x, factoring in a more predictable project pipeline in the next few years and potential upside from China CPU demand (vs valuation surge on cryptocurrency demand in 2017). Key risks: Delay in AI investment, slower-than-expected China CPU penetration, China customers shift to foundry direct business model.

GUC (3443.TW, NEUTRAL, TP NT$250)

We initiate coverage on GUC with a NEUTRAL rating and a target price of NT$250.00 based on 28x 2021E P/E. GUC is the largest IC design service provider in Taiwan with strong technology and capacity support across mature to advanced nodes from TSMC, who owns 35% of the company. We expect the company's sales to see solid growth at an 18% CAGR from 2019-22E with GM of 30%,mainly driven by its customers' AI and 5G investments.

We model GUC's EPS at NT$4.00/NT$8.60 for 2020/21E, factoring in the company's improving growth outlook from AI and 5G investment but less operating leverage. Our target price of NT$250.00 is based on 28x 2021E P/E. The company's stock is at 51x/31x 2020/21 CS estimates, at the upper half of its long-term range between 15-35x P/E. We see the premium valuation also reflects investors' high expectations for solid growth, though any AI project delay in milestone or production could drag the sentiment.

Sector risk:

The following are the key risks to the Taiwan IC design service companies:

- **Macro uncertainty leads to slower semiconductor investment.** We believe the global macro uncertainty triggered by the COVID-19 outbreak could lead to a more conservative investment approach by the IC design service companies' customers as they could push out the semiconductor projects, which was witnessed in GUC's business slowdown in 2009, and 2011-13, along with global economy correction.
- **Slower local CPU penetration in China.** Although China CPU fabless have made good progress on chipset development in the past five years and could replace Intel and AMD's CPU in the mission critical applications. However, we believe the performance and

ecosystem support for most of the solutions developed by local fabless are still lagging their overseas' peers. Although Phytium compared with other local peers has a better technology roadmap (PC CPU on 16nm and server CPU on 7nm), ARM's ecosystem support (vs Loongson's MIPS architecture and Sunway's own architecture) and technology control with permanent license from ARM (vs Zhaoxin and Hygon's x86 architecture), the local CPU penetration could be slower than expected, if the feedback on the China-made CPU and operating system from the users in the government and SOE is not as good, leading to the adoption rate lower than our expectation (30% adoption for PC and low to mid-single digits for server adopted by China government and SOE in the next few years).

- **Consolidation or failure of emerging AI start-ups and system company projects.** With most of the projects in AI ASIC commenced by the start-ups and system companies, the chipset development could take longer than expected, if the spec is changed or the performance does not meet the requirement. In the worst scenario, the projects could fail or the start-ups could be consolidated with other companies, risking the timing of revenue recognition for NRE milestone. For the turnkey business, the timing of the production ramp and volume demand change could impact IC design service companies' revenue.

- **Customers shift to foundry direct business model.** The IC design service companies charge their customers based on the design milestone thy reach in the NRE stage and a mark-up margin for the mass production stage. For smaller players who lack scale and semiconductor knowledge and also supply chain relationship, it is important for them to work with the IC design service companies with long-term track record working on different projects and strong supply chain management. However, if the customers' scale gets bigger with stronger design capability, they could choose to work with foundries directly to avoid the charge from IC design service companies. The most noticeable case in the recent years is the cryptocurrency mining chipset, with Bitmain and Canaan negotiating with TSMC on the capacity support as their scale got bigger.

  We would note the risk is lower for IC design service companies to lose their AI ASIC customers, as the size of each project and the IC design team in the start-ups and system houses is usually smaller, with the chipsets only for customised and more niche applications (vs cryptocurrency mining ASIC widely adopted in mining activity in large scale), so they would still need support from IC design service companies. We believe foundries also prefer to work with IC design service companies for smaller start-ups and system houses, as it allows them to plan capacity in the advanced nodes more easily after experiencing the volatility in cryptocurrency chipset demand in 2017-18. Examples includes Cambricon, an AI chipset start-up in China, has filed for IPO in China A-share market, still works with Broadcom, while Brainchip, focusing on neuromorphic SoC and already listed in Australia, is still working with Socionext in Japan on back-end design.

  For the China CPU projects, we believe the risk is also low for them to move to foundry direct business model as most of the IC design team in local CPU fabless is still relatively small and lacks experience in the leading edge technology design, while the penetration in the domestic market is also low. From the foundry perspective, we believe the political concern may also prevent them from releasing the leading edge reference design and PDK to the government backed companies, leaving room for the IC design service companies.

- **Intensifying competition from Verisilicon in China.** As we have highlighted in the industry section, we believe Verisilicon who plans to IPO in the STAR market could be the key competition in the China domestic market for its peers overseas. However, with its technology and product mix mostly focusing on consumer and edge IoT projects, we believe it could be more of a threat for Faraday, while GUC and Alchip with higher HPC exposure should see milder impact in the next few years. Although Versilicon also targets to build a platform to support more advanced customers in China, we believe it will take time, while its foundry support, mostly from SMIC, GobalFoundries and Samsung, may not be as attractive compared with GUC and Alchip's support from TSMC for the customers requiring advanced node support.

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Alchip Tech

Designing in two engines: AI + China localisation

3661.TW

Target price (12M, NT$)
630.00

Outperform[V]

Semiconductor Devices

- **IC design service proxy for China semiconductor growth.** We initiate coverage on Alchip with an OUTPERFORM rating and a TP of NT$630. Alchip is an IC design service company based in Taiwan and has a strong R&D team in China, with focus on projects including HPC and AI on the advanced nodes. The company's sales saw meaningful growth in 2019, supported by China CPU ramp for PC adopted by the local government and SOE and tape out of the AI project. We believe the company's sales should see 32% CAGR over 2019-22E on more HPC and AI projects from its China and US customers.
- **Key beneficiary of China CPU substitution.** Alchip has been working more aggressively with Phytium, a leading CPU fabless in China, on ARM based processor for PC/NB and server since 2014. The PC CPU project on 16nm started mass production in 2H19 and the server CPU project is also on track for production in 2H20, as China is replacing CPU for government and SOE applications with its own solutions for technology control. With higher China CPU adoption, we estimate the sales from China CPU mass production will contribute 35-40% of Alchip's sales in 2020 and 50% in 2021, as local CPU penetration rises. The company also generates about 10% of sales from supercomputing, with a China project on 7nm booking US$50 mn in late 2020/early 2021.
- **Growing AI projects as second growth engine.** We believe Alchip's AI customer base is diversified, leveraging its experience in HPC. We believe the company has worked on Amazon's projects (Inferentia on 16nm and Graviton on 7nm) and leading AI start-ups including Habana (inference and training—acquired by Intel) and Astera Labs (PCIe-5 re-timer invested by Intel), supporting the company's NRE and turnkey business growth.
- **Healthy growth and operating leverage supports upper-half valuation.** On the growing China CPU and AI market opportunity, we model Alchip's EPS at NT$15.50/NT$21.00 in 2020E/2021E. Our TP of NT$630 is based on 30x of 2021E P/E, at the upper half of its range 10x-30x, factoring in a more predictable project pipeline in the next few years and potential upside from China CPU demand (vs valuation surge on cryptocurrency demand in 2017). Key risks: Delay in AI investment, slower-than-expected China CPU penetration, and China customers shifting to foundry direct business model.

Price (17 Jul 20, NT$)	480.00
Upside/downside (%)	31.3
Mkt cap (NT$/US$ mn)	29,437 / 998.61
Enterprise value (NT$ mn)	26,480
Number of shares (mn)	61.33
Free float (%)	73.7
52-wk price range (NT$)	575-93.00
ADTO-6M (US$ mn)	66.8

[V] = Stock Considered Volatile (see Disclosure Appendix)

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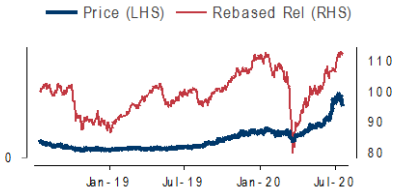
Financial and valuation metrics

Year	12/18A	12/19E	12/20E	12/21E
Revenue (NT$ mn)	3,450.7	4,332.0	6,716.9	8,671.5
EBITDA (NT$ mn)	1,108.0	1,361.6	2,337.8	2,786.9
EBIT (NT$ mn)	321.9	432.9	1,098.8	1,518.8
Net profit (NT$ mn)	257.4	433.5	939.8	1,273.8
EPS (CS adj.) (NT$)	4.2	7.22	15.5	21.0
Chg. from prev. EPS (%)	n.a	n.a	n.a	n.a
Consensus EPS (NT$)	n.a.	7.2	12.12	17.01
EPS growth (%)	(17.4)	71.9	114.5	35.5
P/E (x)	114.2	66.4	31.0	22.9
Dividend yield (%)	0.2	0.3	0.7	1.5
EV/EBITDA (x)	24.7	19.5	11.3	9.3
P/B (x)	10.07	8.72	7.23	5.97
ROE (%)	9.1	13.9	25.6	28.6
Net debt/equity (%)	(71.3)	(85.4)	(76.3)	(74.5)

Source: Company data, Refinitiv, Credit Suisse estimates

Share price performance

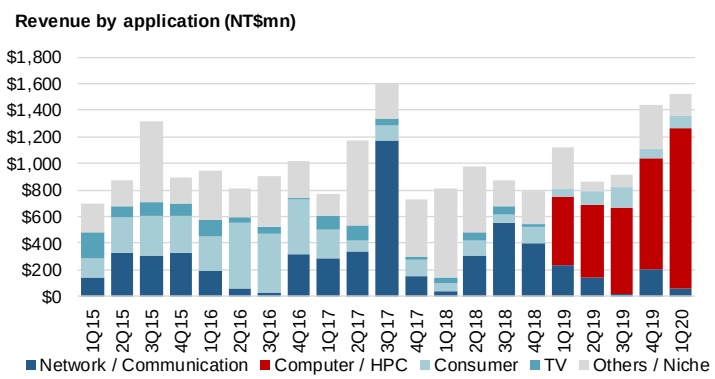


The price relative chart measures performance against the TAIWAN SE WEIGHTED INDEX which closed at 12,181.56 on 17/07/20. On 17/07/20 the spot exchange rate was NT$29.48/US$1

Performance	1M	3M	12M
Absolute (%)	31.0	101.7	435.7
Relative (%)	25.4	86.7	422.9

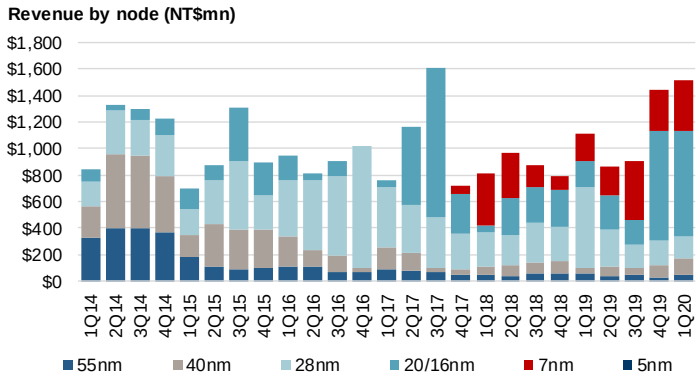
Focus chart and tables

Figure 86: Alchip's revenue growth driven by HPC



Source: Company data, Credit Suisse estimates

Figure 87: 16nm growth is supplemented with 7nm ramp



Source: Company data, Credit Suisse estimates

Figure 88: Alchip's addressable market for China PC/NB and server CPU and supercomputing could reach US$780 mn

Alchip's turnkey business	2019	2020	2021	2022	LT addressable market
China PC CPU shipment (000 units)	400	1,800	2,100	3,000	6,000
China PC CPU ASP from Alchip (US$)	$45	$45	$45	$45	$45
China server CPU shipment (000 units)	0	10	50	150	3,000
China server CPU ASP from Alchip (US$)	$150	$150	$150	$150	$150
China CPU sales contribution	**$18**	**$83**	**$102**	**$158**	**$720**
Supercomputing sales contribution	**$0**	**$7**	**$43**	**$25**	**$60**
China CPU + supercomputing contribution (US$mn)	**$18**	**$90**	**$145**	**$183**	**$780**
Alchip's sales (US$mn)	**$144**	**$224**	**$289**	**$329**	
% of Alchip's sales	**12%**	**40%**	**50%**	**56%**	

Source: Credit Suisse estimates

Figure 89: Alchip's 2Q20-3Q20 and 2020-21 estimates—CS vs street

	2Q20		3Q20		4Q20		2020		2021	
(NT$ mn)	CS	Street	CS	Street	CS	Street	CS	Street	CS	Street
Sales	$1,644	$1,567	$1,704	$1,589	$1,849	$1,780	$6,717	$6,450	$8,671	$8,085
Chg	*8.1%*	*3.0%*	*3.7%*	*-3.4%*	*8.5%*	*12.0%*	*55.1%*	*49.2%*	*29.1%*	*25.3%*
GM (%)	34.1%	36.2%	35.4%	35.6%	36.0%	34.0%	34.7%	34.7%	34.1%	36.1%
OpM (%)	15.4%	14.7%	17.1%	13.0%	18.6%	11.5%	16.4%	13.5%	17.5%	16.2%
EPS (NT$)	$3.60	$3.28	$4.15	$3.11	$4.87	$3.12	$15.50	$12.14	$21.00	$17.01

Source: Company data, The BLOOMBERG PROFESSIONAL™ service, Credit Suisse estimates

Figure 90: Alchip's share at upper half of its range

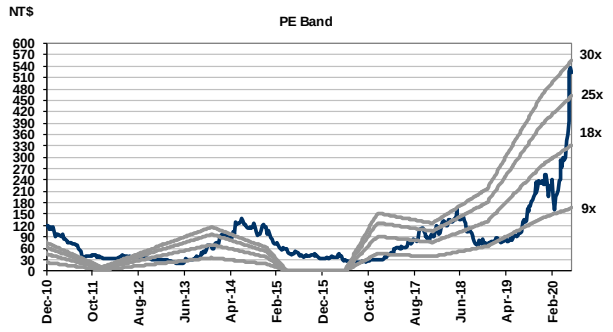
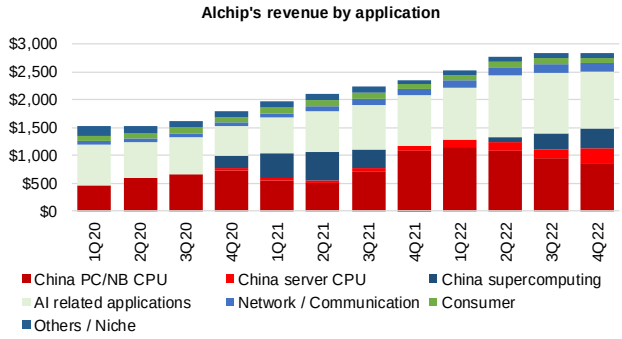


Figure 91: Alchip's business outlook by application



Source: Company data, Credit Suisse estimates

Source: Company data, Credit Suisse estimates

Alchip Tech (3661.TW / 3661 TT)

Price (17 Jul 2020): **NT$480.00** Target Price: **NT$630.00**

Analyst: **Haas Liu**
Rating: **Outperform**

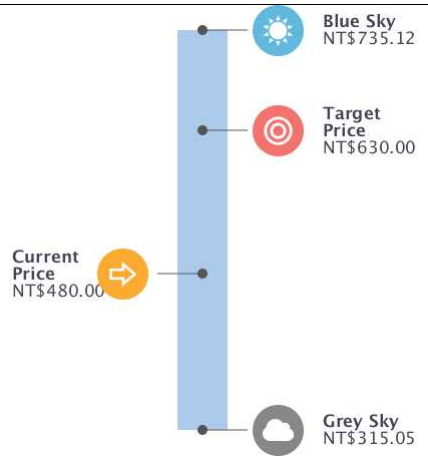
Income Statement (NT$ mn)	12/18A	12/19E	12/20E	12/21E
Sales revenue	**3,451**	**4,332**	**6,717**	**8,671**
Cost of goods sold	2,159	2,721	4,384	5,713
EBITDA	**1,108**	**1,362**	**2,338**	**2,787**
EBIT	**322**	**433**	**1,099**	**1,519**
Net interest expense/(inc.)	(45)	(52)	(51)	(51)
Recurring PBT	**335**	**525**	**1,191**	**1,615**
Profit after tax	**257**	**434**	**940**	**1,274**
Reported net profit	**257**	**434**	**940**	**1,274**
Net profit (Credit Suisse)	**257**	**434**	**940**	**1,274**
Balance Sheet (NT$ mn)	**12/18A**	**12/19E**	**12/20E**	**12/21E**
Cash & cash equivalents	1,765	2,480	2,734	3,295
Current receivables	671	898	1,540	1,911
Inventories	281	582	605	722
Other current assets	167	148	190	227
Current assets	**2,884**	**4,108**	**5,069**	**6,155**
Property, plant & equip.	317	389	599	808
Investments	319	354	354	354
Intangibles	147	222	222	222
Other non-current assets	51	151	151	151
Total assets	**3,717**	**5,225**	**6,396**	**7,691**
Current liabilities	**769**	**1,816**	**2,259**	**2,703**
Total liabilities	**797**	**1,923**	**2,366**	**2,811**
Total debt	0	15	15	15
Shareholders' equity	**2,921**	**3,302**	**4,029**	**4,880**
Minority interests	0	0	0	0
Total liabilities & equity	**3,717**	**5,225**	**6,396**	**7,691**
Cash Flow (NT$ mn)	**12/18A**	**12/19E**	**12/20E**	**12/21E**
EBIT	**322**	**433**	**1,099**	**1,519**
Net interest	0	0	0	0
Tax paid	(77)	(92)	(251)	(342)
Working capital	(391)	(248)	(616)	(391)
Other cash & non-cash items	1,166	1,572	1,682	1,675
Operating cash flow	**1,020**	**1,664**	**1,915**	**2,461**
Capex	(712)	(511)	(1,000)	(1,000)
Free cash flow to the firm	**307**	**1,154**	**915**	**1,461**
Investing cash flow	**(1,258)**	**(295)**	**(1,448)**	**(1,478)**
Equity raised	(158)	0	0	0
Dividends paid	(64)	(91)	(212)	(423)
Financing cash flow	**(224)**	**(76)**	**(212)**	**(423)**
Total cash flow	**(463)**	**1,293**	**254**	**561**
Adjustments	43	(58)	0	0
Net change in cash	**(420)**	**1,235**	**254**	**561**
Per share	**12/18A**	**12/19E**	**12/20E**	**12/21E**
Shares (wtd avg.) (mn)	61	60	61	61
EPS (Credit Suisse) (NT$)	**4.20**	**7.22**	**15.50**	**21.00**
DPS (NT$)	1.07	1.53	3.50	6.97
Operating CFPS (NT$)	16.65	27.74	31.57	40.58
Earnings	**12/18A**	**12/19E**	**12/20E**	**12/21E**
Growth (%)				
Sales revenue	(19.1)	25.5	55.1	29.1
EBIT	0.6	34.5	153.8	38.2
EPS	(17.4)	71.9	114.5	35.5
Margins (%)				
EBITDA	32.1	31.4	34.8	32.1
EBIT	9.3	10.0	16.4	17.5
Valuation (x)	**12/18A**	**12/19E**	**12/20E**	**12/21E**
P/E	114.2	66.4	31.0	22.9
P/B	10.07	8.72	7.23	5.97
Dividend yield (%)	0.2	0.3	0.7	1.5
EV/sales	7.9	6.1	3.9	3.0
EV/EBITDA	24.7	19.5	11.3	9.3
EV/EBIT	85.0	61.5	24.0	17.0
ROE analysis (%)	**12/18A**	**12/19E**	**12/20E**	**12/21E**
ROE	9.1	13.9	25.6	28.6
ROIC	33.4	54.1	120.6	108.8
Credit ratios	**12/18A**	**12/19E**	**12/20E**	**12/21E**
Net debt/equity (%)	(71.3)	(85.4)	(76.3)	(74.5)
Net debt/EBITDA (x)	(1.88)	(2.07)	(1.31)	(1.30)

Source: Company data, Refinitiv, Credit Suisse estimates

Company Background

Headquarted in Taipei, Alchip has footprints around the major semiconductor market to provide its local customers with real time service, including Japan office set up in 2003, Wuxi in 2010, Hefei in 2016, Guangzhou in 2017 and Jinan in 2018.

Blue/Grey Sky Scenario



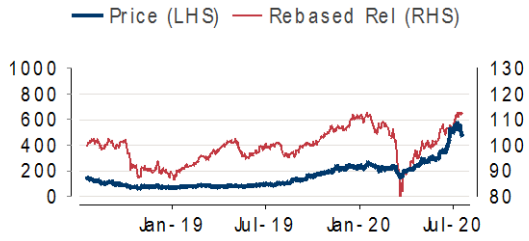
Our Blue Sky Scenario (NT$) **735.12**

Our blue sky scenario implies share price can be up to NT$735.12 on the back of stronger than expected China CPU demand or faster than expected AI and 5G project development.

Our Grey Sky Scenario (NT$) **315.05**

Our grey Sky scenario implies share price can be at NT$315.05 if weaker than expected China CPU demand or its customers fails to deliver on AI or 5G networking projects.

Share price performance



The price relative chart measures performance against the TAIWAN SE WEIGHTED INDEX which closed at 12,181.56 on 17-Jul-2020
On 17-Jul-2020 the spot exchange rate was NT$29.48/US$1

Taiwan IC design service proxy China CPU proxy in Taiwan

Alchip was founded in 2002 by a group of Cadence managers with 20+ years of experience in the semiconductor industry as an IC design and production service provider, as the company management believes it can leverage the third-party IPs to enable customised chipset solutions for its customers in a cost-effective and fast time-to-market way. The company was funded by Cisco Investment and Softbank Investment in the VC Fund in early 2000 and made its IPO on the emerging board in Taiwan in 2010 and on the main board in 2014.

Figure 92: Alchip's milestones

Date	Milestone
Feb-03	Established in the Cayman Islands
Aug-03	1st 0.13um chip design completed
Feb-04	Japan subsidiary established
Jul-04	Joined the TSMC's Design Center Alliance (DCA)
Nov-04	1st SoC design on 90nm completed
Jan-05	Taiwan subsidiary established
Sep-06	Secured digital camera SoC design from Japan customer
May-07	Secured TV SoC design from Japan customer
Jan-08	Secured mobile SoC from a system company
Oct-08	Mass production on 65nm
Dec-09	Mass production on 55nm
Mar-11	Completed tablet PC chipset on 55nm
Sep-11	Completed 40nm project for imaging equipment
Mar-12	Secured 28nm SoC project
Jul-13	Completed bitcoin mining chip on 28nm
Sep-13	Completed supercomputer project on 28nm
Feb-14	Completed bitcoin mining chip on 20nm
Sep-14	Completed entertainment machine project on 28nm for its Japan customer
Oct-14	Listed on the Taiwan Stock Exchange
Jan-17	Completed networking chipset on 16nm for its China customer
Feb-17	Completed HPC project for its China customer
Oct-18	Completed AI project on 12nm
Jun-19	Expanded North America business with new office established
Sep-19	Completed CPU project on 16nm for its China customer
Jan-20	Completed AI project on 7nm for its China customer
Feb-20	Completed networking chipset project on 16nm

Source: Company data, Credit Suisse estimates

Headquartered in Taipei, Alchip has offices around the major semiconductor market to provide its local customers with real-time service, including setting up its Japan office in 2003 when the company was founded. With the fast-growing market in China, the company has set up offices to serve local customers in Wuxi in 2010, Hefei in 2016, Guangzhou in 2017, and Jinan in 2018. The company earlier this year relocated its North America headquarter to Milpitas to serve its customers in the US, with a focus on hyperscalers, OEMs, and fabless for meeting the demand for server farm, and cloud computing, AI, and machine learning, network infrastructure, and autonomous automotive applications.

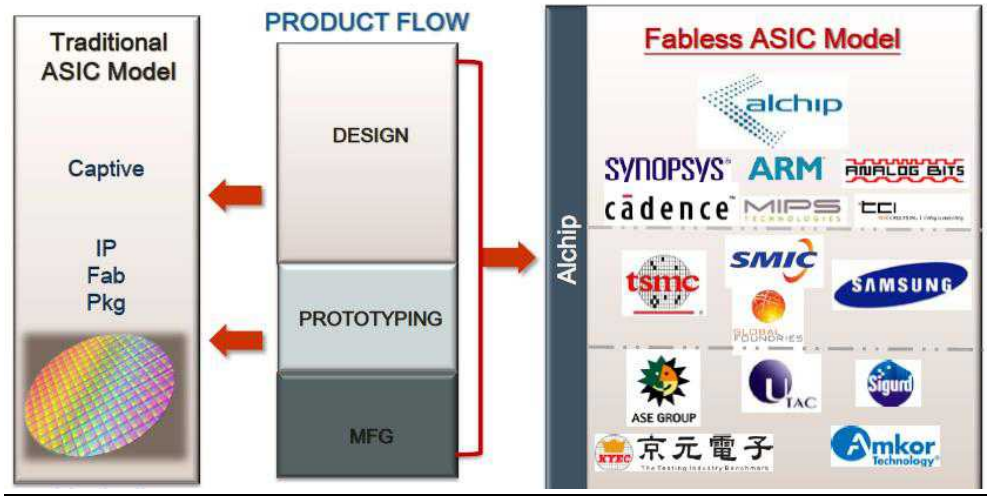
Alchip has strong experience in HPC design and supply chain management

Alchip delivered its 0.13um chipset design platform in 2003, a year after it was founded, and subsequently migrated to 90nm for a high-end consumer SoC design in 2004 and mass

production on the node in 2005. In the following decade, the company was able to catch up with leading foundries' technology migration, supporting its customers with the customized chipsets in the advanced nodes from 65nm in 2006 to 16/14nm in 2015. The company continues to move along with foundries to 7nm in the past few years and expects to start engaging on projects on 6nm and tape outs on the N5P node in 4Q20. Alchip also works with TSMC on CoWoS packaging for high-performance computing applications. The company sees its clocking architecture, timing methodology and advanced routing strategies, also proven by 400+ SoC, to save die size by 15-20% and at the same time improve the yield as the key strengths it can provide to its customers.

For the supply chain relationship, Alchip has also been partnering with multiple foundries (TSMC, Samsung, SMIC) and back-end (ASE, Amkor, JCET and King Yuan), but it mostly relies on TSMC in the front-end production for its advanced capacity support due to its focus on the high-performance computing market. Similar to other IC design service providers, due to long production lead time (4 months for 16nm, 2-3 months for 40 and 28nm), Alchip also provides shuttle services to get the functional validation and process compatibility of a variety of IP blocks for their customers. For IP and EDA tool, Alchip mostly leverages the third-party solutions (e.g., ARM, Cadence and Synopsys) and at the same time provides customised IP for its customers.

Figure 93: Alchip has strong supply chain relationships, from IP to manufacturing



Source: Company data, Credit Suisse estimates

Design service business model

Similar to other IC design service companies, Alchip contracts with its customers in the beginning of the NRE to define the scope of the design, IP usage and turnkey service. The company charges its customers based on the milestone it achieved and also the IP licensing fee. In an NRE project, it in general has 4 milestones for an advanced project, with the first 3 related to chip design, which the company can charge the NRE revenue. The final milestone in NRE is tape-out—in this stage, Alchip will buy one mask from its foundry partners and send the test chip to its customers to make sure the spec, performance and power consumption meet their requirements and decide whether or not to enter the mass production stage. If the customers use Alchip's turnkey service to secure foundry capacity, the company will then recognise production revenue and COGs from the mask procured for manufacturing.

On the other hand, Alchip's customers may also consider to directly seek foundry capacity support after the NRE stage so they can avoid the additional charge by Alchip. However, we would note the foundry capacity in the advanced nodes usually requires full pre-payment for the capacity requested by the new and small-scale customers. In addition, securing foundry capacity in the advanced nodes for smaller customers could be especially challenging as foundries would prioritise the capacity for their major customers during the supply tightness.

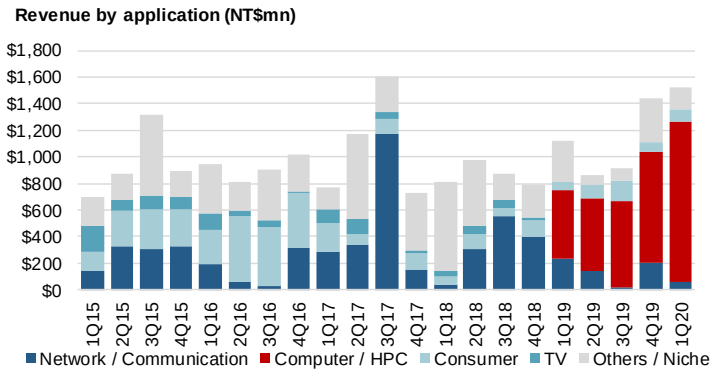
With the unpredictability of the timing for NRE milestone and mass production requested by its customers, the company's revenue could fluctuate on a quarterly basis.

Revenue mix shifting to HPC and networking

Since Alchip started the IC design service business, the company has been focusing on more high-end applications including high-end consumer (game console, TV, digital camera), mobile SoC, high performance computing applications (e.g., supercomputer, data centre, AI and networking), driving its technology migration in the past 2 decades. The company also has some niche legacy projects (e.g., pachinko machine for Yamaha). In 2019, the company derives 59% of revenue from computer and high-performance computing (e.g., CPU for Phytium, supercomputer projects for its China customers, and AI inference chipset for its US internet customers), 19% from niche applications (e.g., Yamaha's pachinko machine), 14% from network/communications, and 9% from consumer applications.

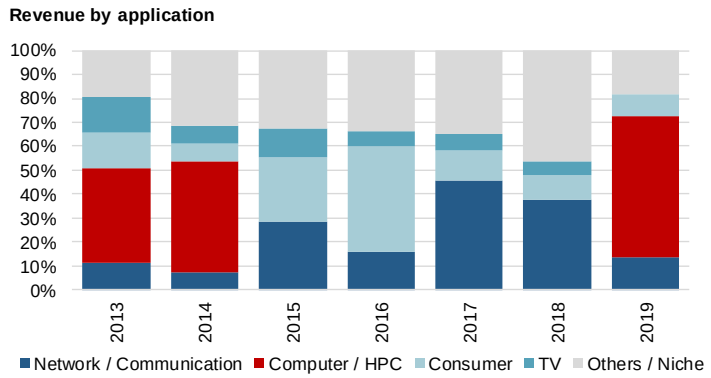
We believe the company's revenue mix by application will be skewed toward the computing and AI companies due to high potential on China CPU from the government push for semiconductor import substitution and fragmented but growing AI ecosystem.

Figure 94: Alchip's revenue growth driven by HPC



Source: Company data, Credit Suisse estimates

Figure 95: Alchip's has 60% revenue from HPC in 2019

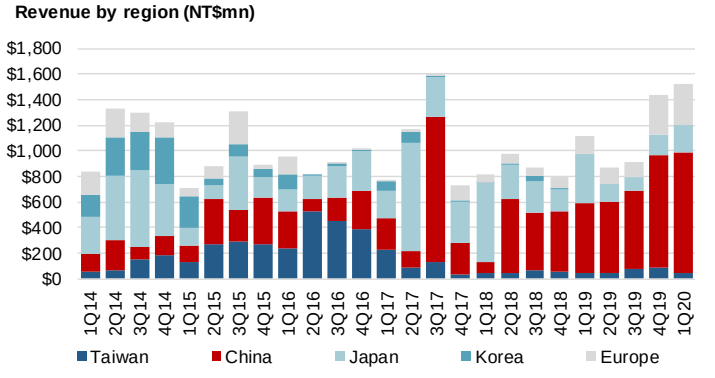


Source: Company data, Credit Suisse estimates

Customers in China and the US will be the major growth drivers in the next few years

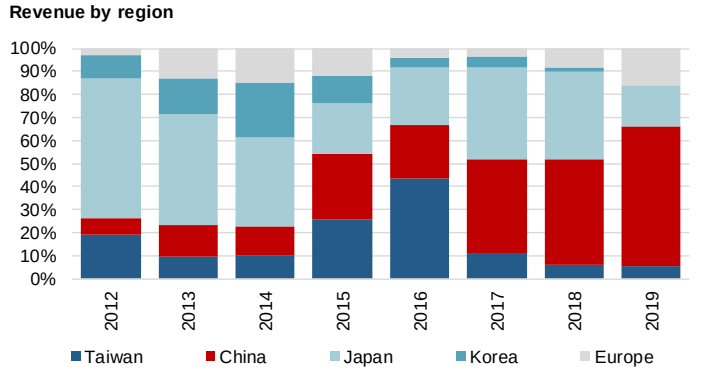
In early 2000, Alchip had high revenue contribution from its Japan customers, mainly supported by management's relationships with local customers, with the applications including supercomputing, digital camera, TV and casino machine.

Figure 96: China business has been growing fast



Source: Company data, Credit Suisse estimates

Figure 97: China has replaced Japan as Alchip's key market



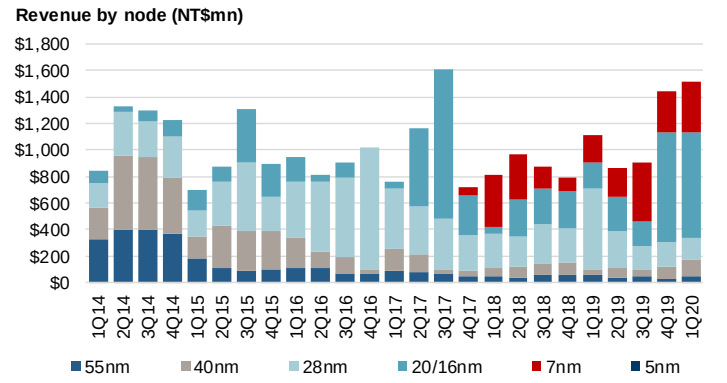
Source: Company data, Credit Suisse estimates

However, the revenue from Japan has been stagnant compared with its China customers with growing project demand for networking chipsets and CPU since 2014. The company's sales from China have grown from 5% in 2011 to 60% in 2019, while its revenue contribution from Japan has declined from 60% in 2011 to 18% in 2019. The company's sales from Europe and the US has risen from 3% in 2012 to 16% in 2019, mainly driven by cloud AI projects NRE milestone and production in 2H19. We expect the company's sales to be driven by its customers in China (CPU substitution and China hyperscaler) and the US (AI cloud) in the next few years.

Projects on advanced nodes continue to drive growth

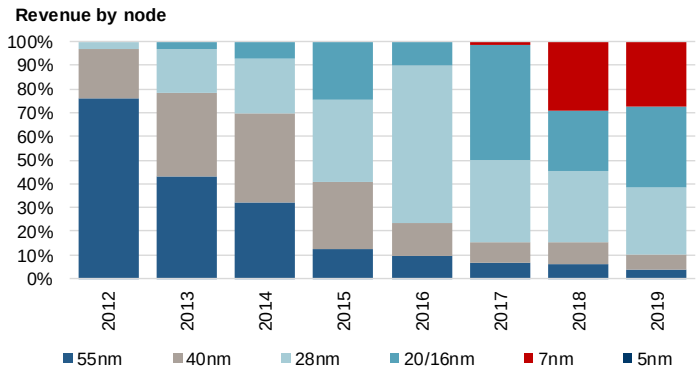
Alchip's revenue by node shifted along with TSMC's technology migration and its targeted applications. With its focus on the most-leading-edge applications, the company's revenue migration to the advanced nodes is faster than GUC, with over 90% of its revenue from 28nm and below. With the strategy focusing on the projects requiring advanced manufacturing technology, the company's revenue in a node peaks in 5 years after the initial revenue recognition with 1-2 years chipset design and 2-3 years mass production for the first- and second-wave applications.

Figure 98: 16nm growth is supplemented with 7nm ramp



Source: Company data, Credit Suisse estimates

Figure 99: Alchip's application mix focuses on 28nm and below



Source: Company data, Credit Suisse estimates

Although the revenue from 16nm is also declining from the peak level in 2017, we expect the contribution from the node could accelerate in 2020 as the company's China CPU customer Phytium announced FT-2000/4 CPU for desktop in 3Q19 and the next generation chipset on 7nm will only tape out in 1H21 and shipment in 2H22. We believe 16nm and 7nm will be the major drivers for the company in the next 2-3 years based on its major customers' product roadmap for CPU and AI and should also see some initial revenue on 5nm from NRE milestone.

Figure 100: Alchip's key projects and customers in 2020 – growth will still be led by HPC business in China

Alchip's sales by application	2019	Key projects in 2020	Major customers
HPC/Computing	59%	China CPU and supercomputing, AI	Phytium, Habana, Amazon
Communication/Networking	14%	Supercomputing	China supercomputing, Astera Lab
Consumer	9%	Video recognition, visual recognition	Altek (for Xiaomi), Orbbec (for Oppo)
Niche	19%	Pachinko machine	Yamaha

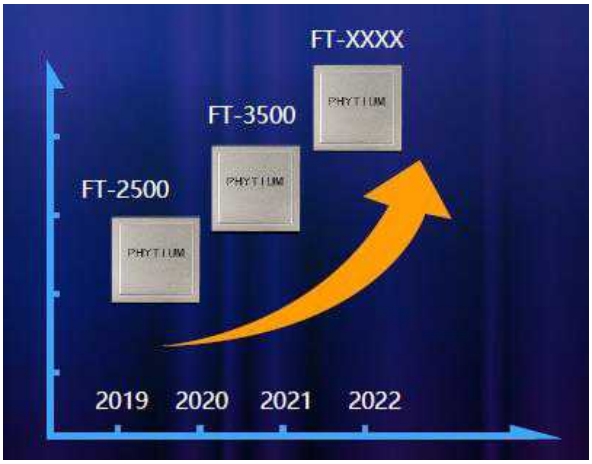
Source: Credit Suisse estimates

Growing CPU design activities and volume ramp along with China's import substitution

As discussed in the industry section, China has been aggressive on building the chipset locally from front-end design and manufacturing to back-end assembly and testing since the National semiconductor development guideline was introduced in 2014 and the trade disputes with the

US in the past few years. The high-end CPU for PC/NB and server, dominated by Intel and AMD, has been one of the key focus areas on the concern over over-reliance on foreign technology, for local players including LoongSon, Phytium, Sunway, Zhaoxin.

Figure 101: Phytium's roadmap for PC and server chipsets



Source: Phytium

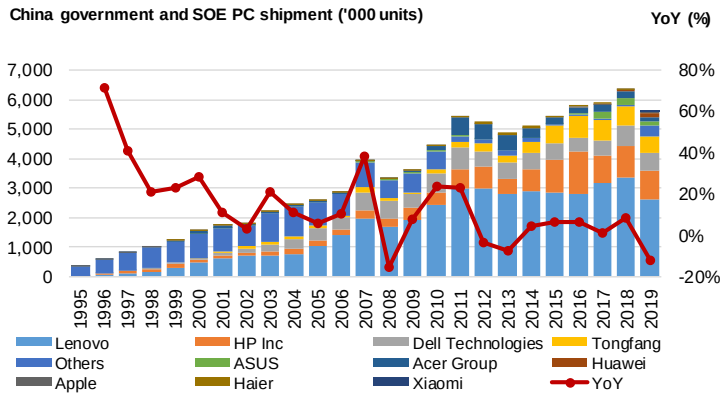
Figure 102: China government could replace Wintel with Phytium CPU + Kylin OS when the ecosystem is more mature

Source: Phytium

For Phytium, the company is a private IC design company backed by the China government, with major shareholders including Great wall Technology owning 31.5%, Tianjin Binhai Civil-Military Integrated Innovation Institute owning 33%, and Tianjin Binhai New Area Investment Group owning 32%. Phytium has accelerated its chip development by licensing ARM architecture since 2014 and co-works with design service companies including Alchip and EES in Taiwan. With the performance and power consumption improvement, ARM's healthy ecosystem and China's more aggressive push on import substitution, Phytium's CPU has roadmap has been migrating from FT1500 series on 28nm in 2014 to FT2000/4 on 16nm in 3Q19.

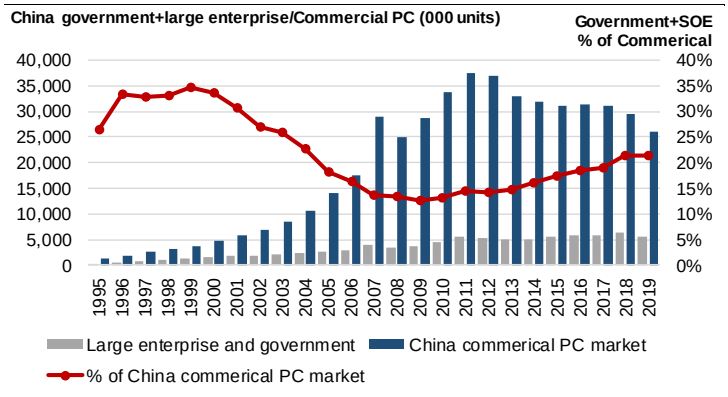
With support from the local downstream supply chain, the company is also working on the PC/NB segment and targeting to replace Intel/AMD in CPU and Microsoft in operating system in the long term, with local partners including Lenovo, Tongfang, Inspur, Bitland, Haisense, Sugon, etc. Its PC CPU shipment, mainly for the China government and SOEs, has surged since 2017, supporting the company's sales to growth from Rmb33 mn in 2017 to Rmb207 mn in 2019, with 75% revenue from PC and 25% from server.

Figure 103: China government and SOE PC shipment at 6 mn units of annual run rate, with local brands gaining share



Source: IDC, Credit Suisse estimates

Figure 104: China government and SOEs represent 20% of domestic commercial PC market



Source: IDC, Credit Suisse estimates

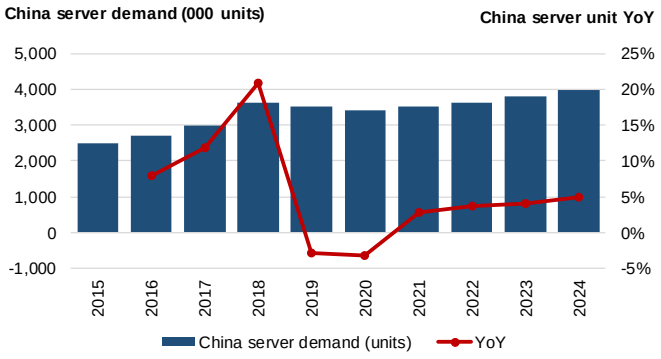
According to IDC, the annual PC demand for the China government and large enterprises (1,000+ employees) has grown from 4.5-5.5 mn in 2010-2014 to 5.5-6.5 mn units in 2015-19. The market is dominated by Lenovo (50% market share), HP (20% share), Dell (10% share), and Tongfang (10% share), while the rest of the market is more fragmented. For the China government PC market specifically, the annual demand is at 3-3.5 mn units, led by Lenovo (48% share), Tongfang (20% share), Dell (10% share), HP (10% share), and other local brands. The market share landscape shift for the China SOE/government market accelerated since 2014, with local players constituting 70-80% of the market share. We expect the trend to continue and the replacement demand could pick up once the CPU technology from local fabless is more mature.

Figure 105: **Phytium's PC CPU already gets qualification by local supply chain**

Source: Phytium

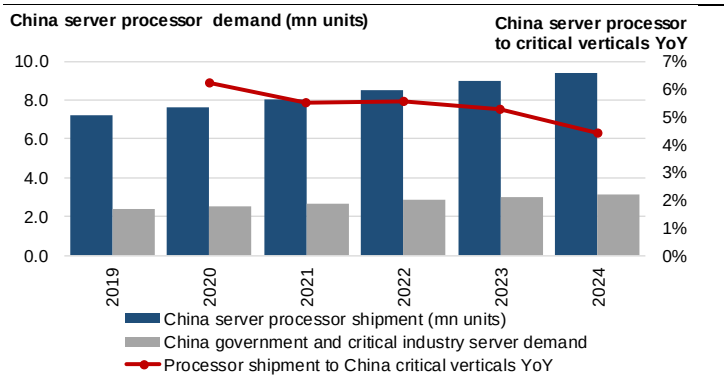
In addition to the PC CPU, Phytium is also working with Alchip on ARM based server CPU, with FT-2500/64 featuring 64 cores on 16nm targeted for shipment from 3Q20 and has second-generation chipset FT-3500 on 7nm already taped out and will start mass production in the beginning of 2021. The company's key partners in server market include Lenovo, Inspur, Sugon, Hisense, Haier, Great Wall, Cloud Kirin, and Tongfang. We believe the initial volume ramp would be supported by its parent company Great Wall (1k-2k units) and gradually penetrate into Lenovo, Inspur, and Sugon who have higher shares in the government server market.

Figure 106: China domestic server demand should reaccelerate



Source: IDC, Credit Suisse estimates

Figure 107: China government and SOE is 20% of server market



Source: IDC, Credit Suisse estimates

For Phytium, we estimate the company shipped 350k CPUs in 2019 and expect the volume to grow to 1.5-2 mn units in 2020 (25-30% of its addressable SOE/government market). Despite the China government's initiative to accelerate import substitution in the semiconductor supply chain and its good progress on PC/NB CPU, we believe Phytium could face more challenges to grow meaningfully in the server market due to the long qualification cycle and performance improvement required for ARM based solutions. With limited contribution from server, Phytium's

Rmb10 bn sales goal by 2024 would imply the PC/NB CPU shipment need to grow to ~10 mn units run rate, higher than its current target market in large SOE and government (6 mn unit annual demand) and its CPU will need to improve on performance, power consumption and app support to expand its addressable market into other commercial and consumer use beyond the government and SOE market.

For Alchip, we estimate the revenue contribution from Phytium has been growing from 13% in 2018 to 28% in 2019 and close to 40% in 2H19 as Phytium started ramping production for its FT2000/4 PC CPU on 16nm since 3Q19. The strength from its PC CPU builds has continued into 1Q20 as the company already has 1 mn chipsets in production by the end of 2019 (3k wafer demand for TSMC based on 180mm^2 die size). With its CPU for NB and PC leading in the government and SOE market, we expect Phytium to build 1.5 mn chipsets in 2020. At US$40-50 per chipset, we estimate Phytium's PC CPU business could contribute US$60-75 mn to Alchip in 2020 (30-35% of its sales).

Phytium's new server chipset has also tapped out and is targeted to start shipment from 3Q20. Although the server volume may be milder in the initial stage, we believe the pricing opportunity is much higher compared with PC/NB CPU, due to larger die size and on the more advanced node at US$150 per server CPU, potentially contributing US$1.5 mn turnkey revenue to Alchip in 2021E, based on the assumption of 10k unit shipment.

Figure 108: IC design service has US$40-50 content per PC CPU on 16nm and US$150 per server CPU on 7nm for China fabless

	PC	Server
Die size	230	370
Manufacturing node	**16nm**	**7nm**
Total wafer area	70,650	70,650
Usable area	85%	85%
Yield	90%	85%
Chip on wafer	**235**	**138**
Wafer price (US$)	$5,625	$11,250
Wafer cost per chip	$24	$82
Mask cost/chip	**$3**	**$13**
Front + Back-end cost	**$32**	**$109**
Total COGs for IC design service (US$)	**$34**	**$121**
Turnkey GMs for IC design service	**18%**	**20%**
Chipset price to the customers (US$)	**$42**	**$152**

Source: Credit Suisse estimates

We also provide an estimate of Alchip's addressable market in PC/NB and server CPU for the China government and SOE, based on the assumption of Phytium's high market share in this market, supported by its strong technology roadmap and ARM ecosystem support. Based on the annual run rate of 5 mn PC shipment on 16nm (80% of the 6 mn China government and SOE market) and 3 mn server shipment on 7nm (60% of the market) for China government and SOE, we estimate the addressable market for Alchip could reach US$210 mn and US$455 mn for PC/NB and server, respectively.

Figure 109: Alchip's addressable market for China PC/NB and server CPU and supercomputing could reach US$780 mn

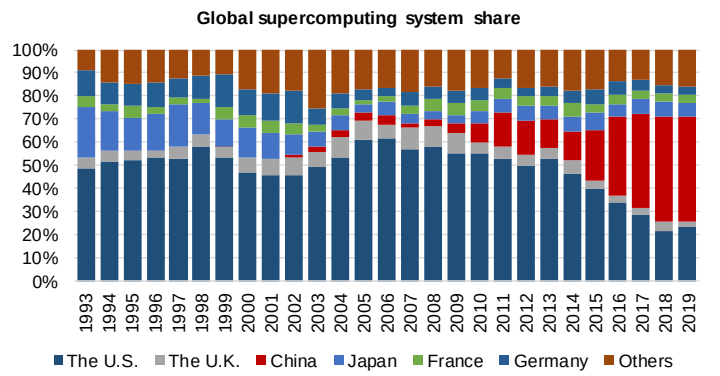
Alchip's turnkey business	2019	2020	2021	2022	LT addressable market
China PC CPU shipment (000 units)	400	1,800	2,100	3,000	6,000
China PC CPU ASP from Alchip (US$)	$45	$45	$45	$45	$45
China server CPU shipment (000 units)	0	10	50	150	3,000
China server CPU ASP from Alchip (US$)	$150	$150	$150	$150	$150
China CPU sales contribution	**$18**	**$83**	**$102**	**$158**	**$720**
Supercomputing sales contribution	**$0**	**$7**	**$43**	**$25**	**$60**
China CPU + supercomputing contribution (US$mn)	**$18**	**$90**	**$145**	**$183**	**$780**
Alchip's sales (US$mn)	**$144**	**$224**	**$289**	**$329**	
% of Alchip's sales	**12%**	**40%**	**50%**	**56%**	

Source: Credit Suisse estimates

Supercomputer should also see new system contribution on 7nm from late 2020

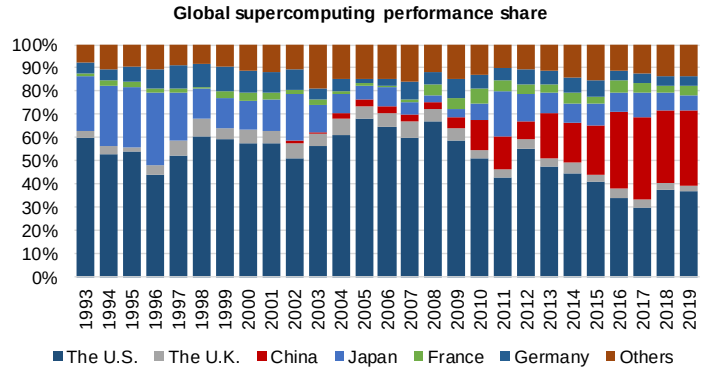
In our industry section, we also discuss China's import substitution not only happens in desktop and server CPU, but also on the most-leading-edge supercomputing. Although China has been fast developing its supercomputing system for scientific use, with its unit share among global top 500 supercomputing system from 0% in 2000, 8% in 2010 and 46% in late 2019, most of the critical semiconductor components are still sourced from Intel for CPU and AMD/Nvidia for accelerator. The concerns from the US government on the use of Intel's chipsets in China's supercomputing systems for nuclear tests prompted the US decision to stop Intel from shipping its Xeon products to Chinese supercomputing institutions since 2015.

Figure 110: China continues to grow system share



Source: IDC

Figure 111: China's performance share has been stagnating



Source: IDC

To replace solutions provided by overseas suppliers, China's local institutions have been working on developing their own supercomputing CPU and accelerator based on different architecture since 2015, with 3 major ones including Loongson (MIPS), Sunway (ALPHA) and Phytium (ARM). China National University of Defense and Technology developed the Matrix-2000 accelerator on 28nm which replaced Intel's Xeon PHY chipset and was deployed in the Tianhe-2A supercomputing system in the National Supercomputing Center of Guangzhou since 2017. The company also has been working with Tianhe for the network-interconnect design since 2012 and adopted in the Tianhe-1 and Tianhe-2 supercomputers. The company subsequently developed Matrix-2000+ accelerator on 16nm in 2017 for the Tianhe-3 prototype.

For Alchip, the company has a long history of developing chipsets for supercomputing systems. In 2006, the company worked with the University of Tokyo on the chipset manufactured on TSMC's 90nm. It also had Japan supercomputing fabless PEZY as one of its important supercomputing customers in 2017. In recent years, with China's focus on high-end technology and the country also seeking domestic substitution of the semiconductor content, Alchip started the relationship with the China supercomputing industry since 2010. The company was once working with Sunway on the supercomputing system but has stopped the business.

Figure 112: Supercomputing could represent another opportunity for Alchip

Supercomputing opportunity	2017	2018	2019	2020	2021	2022
China	$35	$0	$0	$7	$43	$25
Japan	$30	$0	$0	$0	$0	$0
Supercomputing sales	**$65**	**$0**	**$0**	**$7**	**$43**	**$25**
Alchip's sales (US$mn)	**$142**	**$115**	**$144**	**$224**	**$289**	**$329**
% of Alchip's sales	**46%**	**0%**	**0%**	**3%**	**15%**	**8%**

Source: Credit Suisse estimates

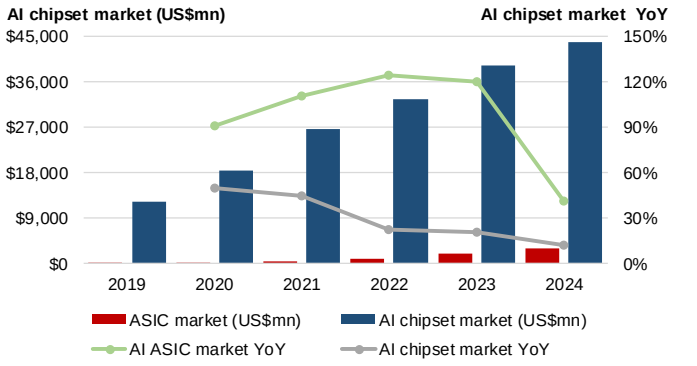
We believe Alchip is now expanding its business in supercomputing beyond networking chipsets to core CPU design, with its second-largest customer on 7nm for the customer's next

generation supercomputing system. The first project was taped out in 1Q20 and set for shipment by the end of this year. The second project is targeted for tape out in 1H21 and shipment by the end of 2022. With the extent of CPU required in a supercomputing system is high, we estimate Alchip's content in a system reached US$30-40 mn for a 16nm project and will grow to US$50 mn for the projects on 7nm, contributing 15% of the company's sales in 2021E if the chipset development and shipment are on track to its expectation.

AI ASIC volume could start ramping up from 2020

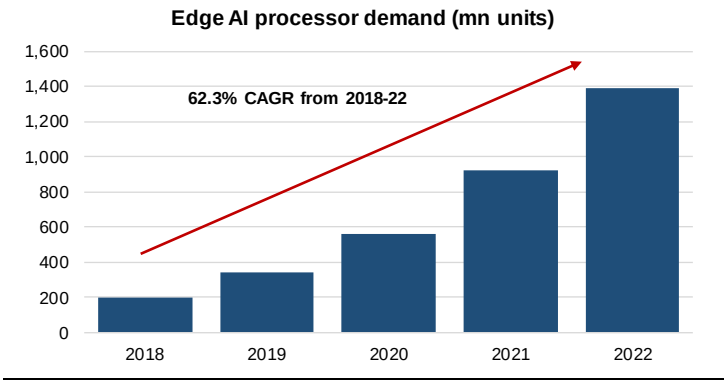
In our industry section, we highlight the global AI market will grow from US$56 bn in 2018 to US$163 bn in 2022, at a CAGR of 30%, mainly led by the US and China. The global start-up investment on AI technology and application has also been accelerating from US$1.3 bn raised in 2010 to ~US$45 bn in 2019, with an average investment size of US$8.6 mn, according to CAPIQ. The start-ups in the US and China in total received 75% of ~US$85 bn investment in 2018-19. In addition to the start-ups, the established corporates globally are also making more investments on AI growing from US$3 bn in 2010 to ~US$80 bn in 2019, mostly through M&A (30-35%) and VC driven private investment (35-40%). The focus of the AI investment is diversified, the major ones including autonomous driving (10%), drug study (6%), facial recognition (6%), digital content (4.5%), and finance authentication (4%). The global investment by AI start-ups in semiconductor has grown by 450% from US$0.5 bn in 2015 to US$2-3 bn in 2019, as more and more companies try to customise their chipsets solutions and improve the AI performance and power consumption.

Figure 113: AI ASIC is going to outgrow the AI semiconductor market



Source: Gartner, Credit Suisse estimates

Figure 114: Edge AI processor is projected to reach 1.4 bn units in 2022

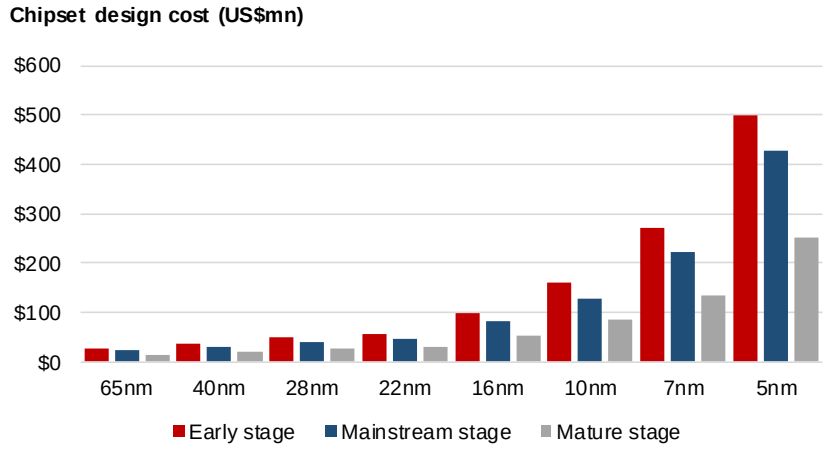


Source: IDC, Credit Suisse estimates

We believe the chipset customised design and differentiation for dedicated applications and use cases should drive the investment in AI semiconductor and be key trend in AI development when the market opportunity gets bigger. The AI chipset development is still fragmented due to a wide range of industry use cases, with 326 companies in China alone in 2019, according to ChinaVenture Institute. For the major system companies, the most noticeable investment on AI chipset including Google's TPU, Amazon's Inferentia, Graviton (training), IBM's TrueNorth NPU, Baidu's Kulun chipset (training + inference) and Honghu (far-field voice interaction), Alibaba's Hanguang 800 NPU and Huawei's Ascend 910. However, the investment required for the chipset design in the advanced nodes is high from IP qualification architecture, verification to software prototype and validation, with design cost up to US$130 mn on 16nm, US$300 mn on 7nm and US$50 0mn on 5nm, according IBS.

With high chipset design and manufacturing cost in the advanced nodes compared to the funding the AI start-ups get, we believe these companies would be more cautious on the design process, presenting a good potential for the IC design service companies. For the system companies who would like to design ASIC for their own AI solutions, they would also leverage IC design service companies to ensure high yield and time to market.

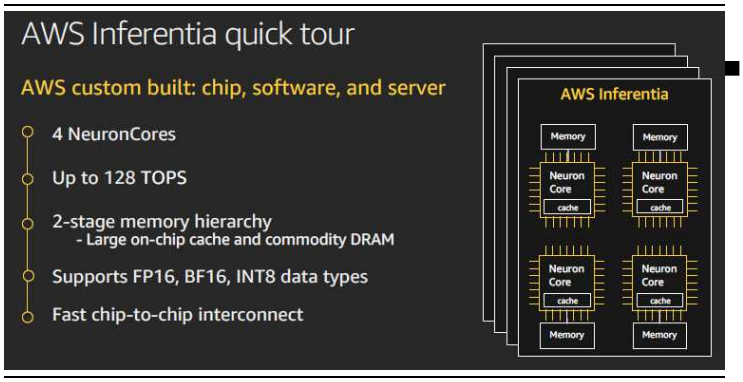
Figure 115: **IC design cost surges in the advanced nodes**



Source: IBS Research, Credit Suisse estimates

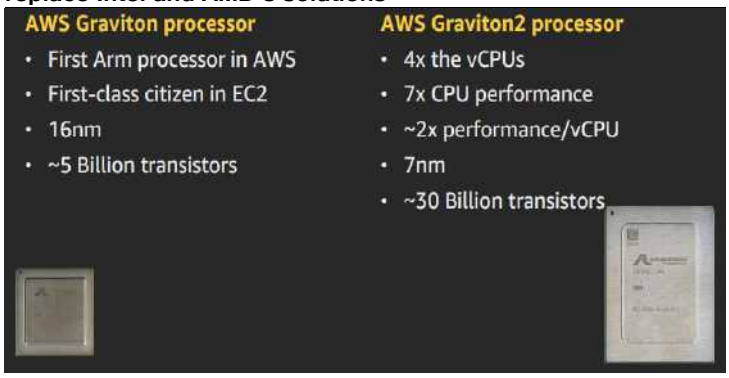
For AIChip, we believe Alchip has been working with Amazon on the Inferentia chipset on TSMC's 16nm for inference, which taped out in 3Q19 and started mass production from 4Q19 to AWS. In addition to Amazon, Alchip has also provided IC design services to Habana, an AI chip fabless in Israel acquired by Intel in late 2019 to compete with Nvidia, for the inference and training chipsets on 7nm.

Figure 116: Amazon highlighted its Inferentia chipset for AI inference



Source: Amazon

Figure 117: Amazon also plans to use its Graviton processor to replace Intel and AMD's solutions



Source: Amazon

The processor is currently sampling with some hyperscalers and the company claims to deliver up to a 4x increase in throughput vs the equivalent number of GPUs. Alchip is also working with Astera Labs, a start-up fabless backed by Intel Capital and TSMC's manufacturing capability, on PCIe-5 solutions for high-speed connection in data centre. The company has delivered chipset on 16nm in 4Q19 and is targeting to develop 7nm solutions. In addition to the U.S. internet and system customers, Alchip could also benefit from the outsourcing demand from China hyperscalers for the back-end design for their ASIC on 7nm from 2021-22.

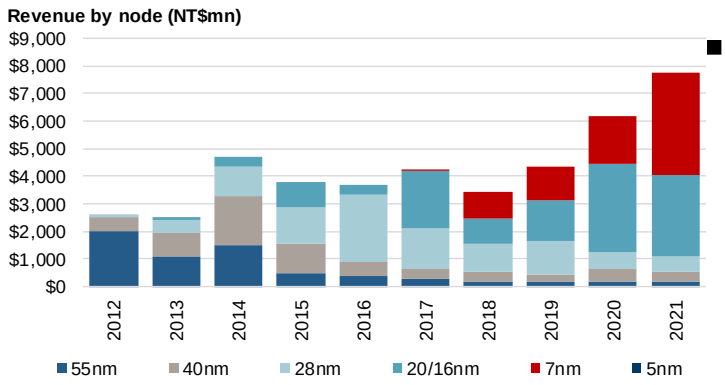
Compared with its opportunity in China CPU for volume ramp for import substitution, we believe the company can be selective and benefit from the growing NRE potential in the fragmented AI market though the volume could be milder as each chipset is customized for certain application or customer.

Business should reaccelerate close to year-end

Alchip's 1Q20 sales were up 6% QoQ and 36% YoY, supported by NRE revenue recognition from 7nm CPU tape out, offsetting slower Phytium's PC CPU demand following the inventory builds in 4Q20. Alchip's 2Q20 sales were up 8% QoQ, above the company's expectation for

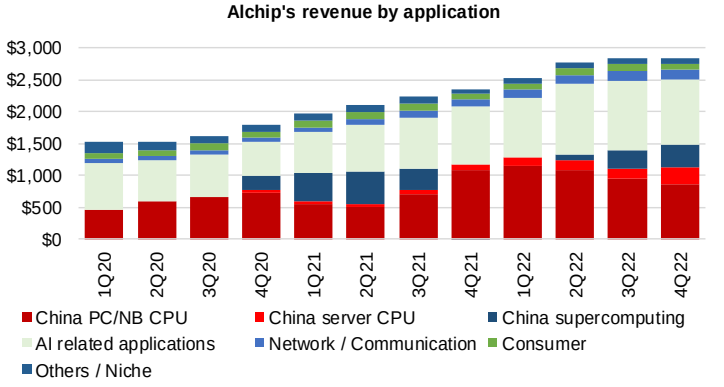
flat QoQ, supported by continued strength for China PC CPU customer and the ramp of AI chipset for its US customer. We expect the business to stay healthy in 2H20, mainly supported by stable Phytium PC CPU and continued NRE activities for the AI and CPU projects. We expect Alchip's sales to accelerate in 4Q20 along with the new server chipset on 7nm ramping production, putting full year sales on track to grow 40-45% YoY.

Figure 118: 16nm and 7nm should be the key nodes to drive Alchip's growth in the next few years



Source: Amazon

Figure 119: Alchip's business outlook by application from 2020-22



Source: Amazon

CPU substitution in China and growing AI market support strong growth outlook in 2021-22

We model Alchip's growth will stay solid at 30% CAGR from 2019-2022, with strong growth supported by growing PC/NB CPU demand from China government and SOE on the back of China's policy to accelerate semiconductor import substitution. The enterprise server replacement demand for large enterprise and government in China should be the second-wave demand driver for Alchip from 2021-22. The company's opportunity in supercomputing should also grow with higher content on the advanced nodes in addition to its existing networking IC business.

Figure 120: Alchip's business outlook by application over 2020-22

	1Q20	2Q20	3Q20	4Q20	1Q21	2Q21	3Q21	4Q21	2020	2021	2022
China PC/NB CPU	$450	$600	$650	$730	$550	$500	$700	$1,085	$2,430	$2,835	$4,050
China server CPU	$0	$0	$0	$45	$35	$50	$60	$80	$45	$225	$675
China supercomputing	$0	$0	$0	$214	$450	$500	$336	$0	$214	$1,286	$750
AI related applications	$751	$698	$696	$471	$585	$680	$659	$581	$2,617	$2,505	$2,314
Computer / HPC	**$1,201**	**$1,298**	**$1,346**	**$1,460**	**$1,620**	**$1,730**	**$1,755**	**$1,746**	**$5,306**	**$6,850**	**$7,789**
YoY					35%	33%	30%	20%	108%	29%	14%
Network / Communication	**$61**	**$66**	**$68**	**$74**	**$82**	**$88**	**$89**	**$88**	**$269**	**$347**	**$394**
YoY					35%	33%	30%	20%	-55%	29%	14%
Consumer	**$91**	**$99**	**$102**	**$111**	**$123**	**$131**	**$133**	**$133**	**$403**	**$520**	**$592**
YoY					35%	33%	30%	20%	4%	29%	14%
Others / Niche	**$167**	**$181**	**$187**	**$203**	**$226**	**$241**	**$244**	**$243**	**$739**	**$954**	**$1,085**
YoY					35%	33%	30%	20%	-8%	29%	14%
Total	**$1,520**	**$1,644**	**$1,704**	**$1,849**	**$2,050**	**$2,190**	**$2,221**	**$2,210**	**$6,717**	**$8,671**	**$9,860**
YoY					35%	33%	30%	20%	55%	29%	14%

Source: Company data, Credit Suisse estimates

In addition to the China CPU demand, the company should also benefit from the trend of chipset design by a diversified customer portfolio across established system companies and start-ups in the expanding AI processor market for cloud and edge computing.

Figure 121: Alchip's 2Q20-3Q20 and 2020-21 estimates—CS vs street

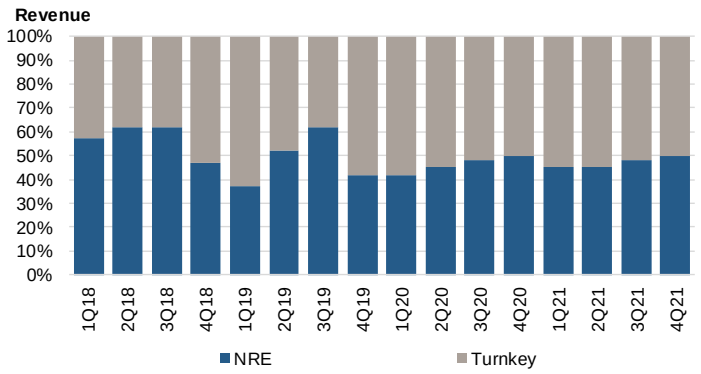
	2Q20		3Q20		4Q20		2020		2021	
(NT$ mn)	CS	Street	CS	Street	CS	Street	CS	Street	CS	Street
Sales	$1,644	$1,567	$1,704	$1,589	$1,849	$1,780	$6,717	$6,450	$8,671	$8,085
Chg	*8.1%*	*3.0%*	*3.7%*	*-3.4%*	*8.5%*	*12.0%*	*55.1%*	*49.2%*	*29.1%*	*25.3%*
GM (%)	34.1%	36.2%	35.4%	35.6%	36.0%	34.0%	34.7%	34.7%	34.1%	36.1%
OpM (%)	15.4%	14.7%	17.1%	13.0%	18.6%	11.5%	16.4%	13.5%	17.5%	16.2%
EPS (NT$)	$3.60	$3.28	$4.15	$3.11	$4.87	$3.12	$15.50	$12.14	$21.00	$17.01

Source: Company data, The BLOOMBERG PROFESSIONAL™ service, Credit Suisse estimates

GMs sustains at mid-30% along with OpM expansion from higher turnkey revenue scale

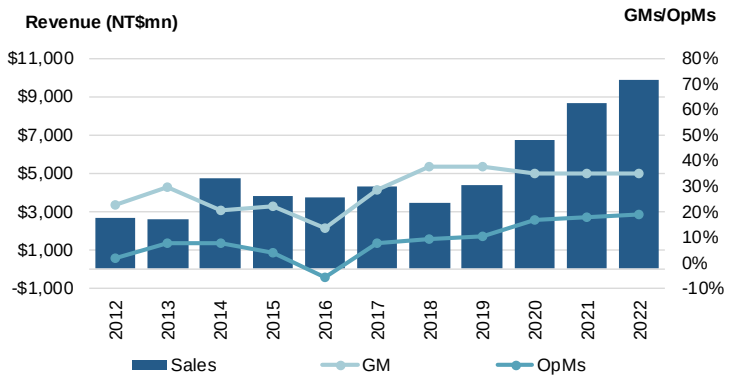
Alchip's GMs is highly correlated with its mix of NRE vs turnkey. In the NRE stage, most of the costs are related to chip design in R&D expense (opex) and limited COGs have occurred before entering mass production. For turnkey service, due to the high cost for mask layers it needs to procure for its customers (US$1.5 mn for 28nm, US$3 mn for 16nm and US$6 mn for 7nm), the high pass-through cost would impact Alchip's margins profile, especially in the initial stage when the mask starts to depreciate.

Figure 122: Alchip should continue to keep its NRE at 45-50% of its revenue with new projects flow in



Source: Company data, Credit Suisse estimates

Figure 123: Alchip should keep its margins stable and some operating leverage from ramping China CPU business



Source: Company data, Credit Suisse estimates

Based on our estimate, Alchip's GMs for its NRE business in general is at the 30-50% range, higher compared with turnkey service at 10-30%, depending on the complexity of the project (HPC is higher compared with consumer in general). In the past two years, the company's NRE contribution declined from 55-60% of its sales in 2018 to 45-50% in 2019, but was able to keep its margins stable at 37%, supported by a higher mix for the HPC business.

The company's GM was down from 46% in 3Q19 to 33% in 4Q19, mainly due to higher cost on 7nm. In 1Q20, the company's GMs was stable QoQ at 33% due to higher NRE contribution while turnkey business declined modestly following the PC CPU shipment pull in 4Q19. We expect the margins should improve QoQ from 1Q20 levels following the initial spending on the mask on 7nm and more NRE contribution. However, with more production for China CPU offsetting AI projects kicking in for NRE business, we expect the company's contribution from its NRE business to stay at 45-50% in 2020 while higher depreciation cost for 7nm mask should drag GMs from 37% in 2019 to 35%.

To support growing business opportunity, the company plans to increase its headcount by 30-40% YoY by the end of 2020. Although the room for OpMs expansion could be limited in 2020

due to more aggressive engineering hiring, we believe the investment should support the company to service more customers in the next few years.

Alchip's fab-lite model supports a solid balance sheet

Figure 124: Alchip's balance sheet is healthy

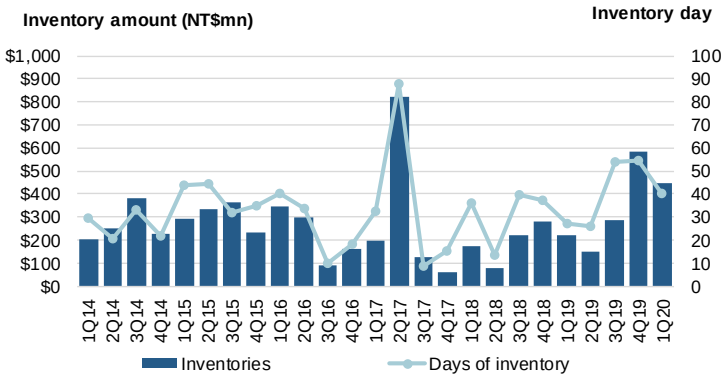
Balance Sheet (NT$ mn)	1Q20A	4Q19	Diff %
Cash and Investments	2,449	2,702	-9%
Total Debt	15	15	
Net Cash	2,433	2,687	-9%
Net Cash/Share	**42.31**	**46.85**	**-4.54**
Accts. Receivable	1,417	898	58%
Receivable Days	**85**	**57**	**28**
Inventory	449	582	-23%
Inventory Days	**40**	**55**	**-14**
Accounts Payable Days	32	39	-7
Cash Conversion Cycle	**93**	**73**	**21**
SH Equity	3,476	3,302	5%
Book Value / Share	**57.32**	**54.87**	**2.45**

Source: Company data, Credit Suisse estimates

As a semiconductor IC design service provider, Alchip only helps to design the chipsets for its customers and source the manufacturing to its foundry and back-end partners, rather than produce chipsets. Although its inventory levels can be volatile, depending on the shipment schedule, its customers are required to take all of the chipsets after the production, limiting the inventory risk. The company's customer base is diversified from start-ups to established system houses, but the payable risk is limited, as the company is able to keep receivables at 25-95 days.

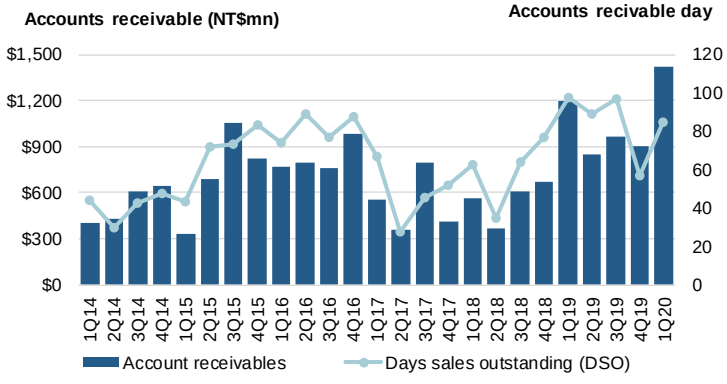
On the cash position, Alchip has NT$2.4 bn net cash (NT$42.31 net cash per share) with limited debt. We expect the company to generate solid cash flow from healthy sales growth more than offsetting volatility in GMs and sufficient for it business operation and dividend payout.

Figure 125: Alchip keeps its inventory level stable



Source: Company data, Credit Suisse estimates

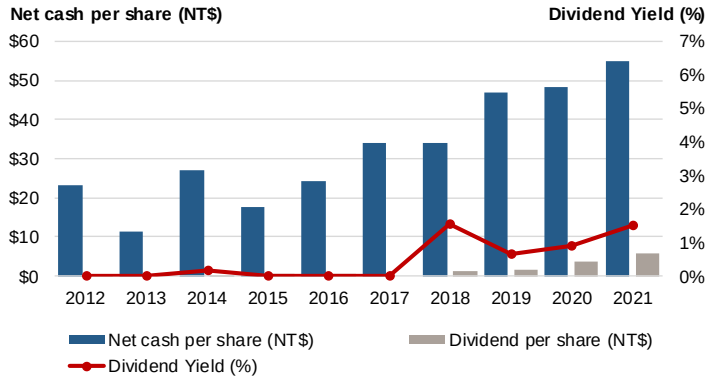
Figure 126: Alchip's AR days is still within long-term range



Source: Company data, Credit Suisse estimates

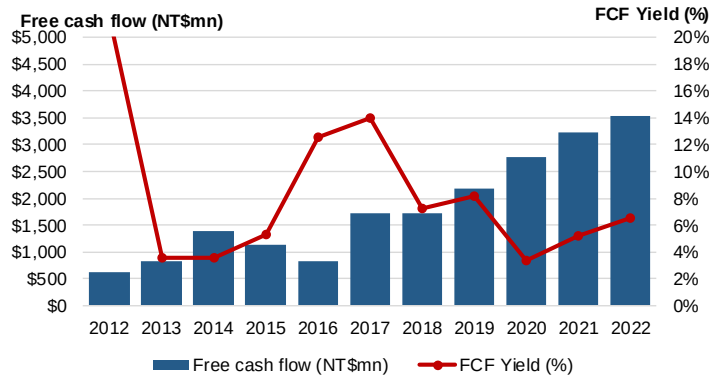
Healthy cash flow supports a steady growth dividend

Figure 127: Alchip's improving cash position should improve the payout



Source: Company data, Credit Suisse estimates

Figure 128: Alchip's FCF yield should improve to 5-8% in 2020-22E



Source: Company data, Credit Suisse estimates

Although Alchip's business is a capital light semiconductor IC design service model, the company still needs to procure mask layers and EDA tool upgrade which are more expensive in the advanced nodes, lifting capex intensity from 8% from 2012 to 10-20%. We estimate the company's capex to grow to NT$1 bn annual run rate in 2020-21, but the solid business outlook should still keep its FCF growing from NT$400 mn in 2012 to NT$2 bn by 2021, sufficient to support a 50% dividend payout policy.

Figure 129: Alchip's asset light business model should continue to generate healthy FCF

Annual (NT$mn)	CY12	CY13	CY14	CY15	CY16	CY17	CY18	CY19	CY20	CY21	CY22	CY03-17 Avg
Revenue	2,623	2,584	4,692	3,786	3,691	4,266	3,451	4,332	6,717	8,671	9,860	3,341
Capital spending	-219	-351	-589	-502	-295	-475	-712	-511	-1,000	-1,000	-1,000	-371
Capex/Revenue (%)	**8.3**	**13.6**	**12.6**	**13.3**	**8.0**	**11.1**	**20.6**	**11.8**	**14.9**	**11.5**	**10.1**	**11.1**
Dep and amort	305	345	647	697	608	501	786	929	1,239	1,268	1,270	448
Depr/Revenue (%)	**11.63**	**13.36**	**13.79**	**18.41**	**16.48**	**11.75**	**22.78**	**21.44**	**18.45**	**14.62**	**12.88**	**13.42**
Operating cash flow	395	466	788	617	535	1,242	1,020	1,664	1,915	2,461	2,751	562
Free cash flow	**176**	**115**	**199**	**115**	**240**	**768**	**307**	**1,154**	**915**	**1,461**	**1,751**	**192**

FCF and Dividend Yields	CY12	CY13	CY14	CY15	CY16	CY17	CY18	CY19	CY20	CY21	CY22	CY03-17 Avg
FCF / Share (NT$)	6.54	2.13	3.64	1.83	3.91	12.65	5.02	19.23	15.08	24.10	28.87	3.36
FCF Yield (%)	21.7	3.5	3.6	5.3	12.5	14.0	7.3	8.2	2.9	4.7	5.6	7.5
FCF / EV (%)	**1.5**	**1.0**	**1.7**	**1.0**	**2.0**	**6.5**	**2.6**	**9.8**	**7.8**	**12.4**	**14.9**	**1.6**
Dividend per share (NT$)	0.00	0.00	0.18	0.00	0.00	0.00	1.07	1.53	3.50	6.97	10.50	0.03
Pre-Dividend closing price (NT$)	30.10	60.00	101.00	34.20	31.25	90.50	69.00	234.50	515.00	515.00	515.00	62.76
Dividend Yield (%)	**0.0**	**0.0**	**0.2**	**0.0**	**0.0**	**0.0**	**1.5**	**0.7**	**0.7**	**1.4**	**2.0**	**0.3**

Source: Company data, Credit Suisse estimates

Strong earnings outlook fuelled by China CPU and AI

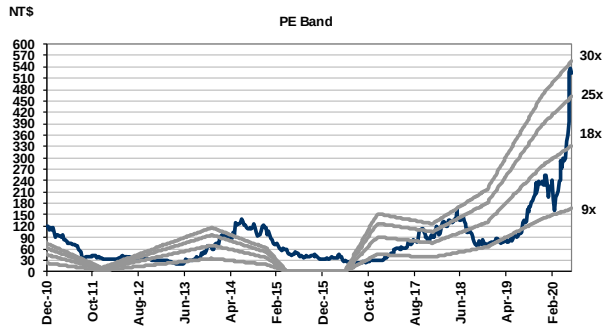
We believe Alchip will be one of the key beneficiaries of China's initiative to replace overseas CPU with its self-developed chipset solutions for the government, SOE and supercomputing system in the next few years. The company should also grow along with the expanding AI addressable market with its system house and start-up customers.

On the growing HPC and networking market opportunity, we expect Alchip's sales to grow 55%/29% YoY in 2020/21 at 35% GM, and 15% operating margin, supporting the company to generate NT$6.7 bn/NT$8.7 bn sales, NT$940mn/NT$1,274 mn in profit, and NT$15.50/NT$21.00 of EPS in 2020/2021.

Target price reflects 30x the 2021E opportunity

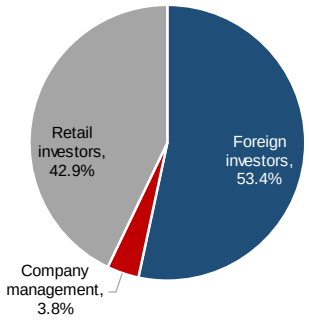
Alchip is currently trading at 34x/25x 2020/2021E CS estimates, vs. its long-term range of 10x-30x. Compared with the last time the company's valuation surging to 30x P/E driven by the cryptocurrency ASIC demand, we believe the company' solid growth outlook from China semiconductor localization and drivers from growing AI ASIC in the next few years sustain a higher valuation.

Figure 130: Alchip's share at the upper half of its 10x-30x range



Source: Company data, Credit Suisse estimates

Figure 131: Alchip's ownership



Source: Company data, Credit Suisse estimates

We set our TP at NT$630, reflecting 30x our 2021E EPS of NT$21.00, factoring in our expectation for 30% sales CAGR from 2019-22, implying 20% upside from the current price of NT$522. We believe the upper half of the long-term valuation should be supported by the company's earnings upside from stronger-than-expected China PC CPU replacement demand and faster-than-expected Phytium's server CPU penetration into the China government and SOE projects.

Alchip trades at a premium to its peers on better business outlook

Figure 132: Taiwan IC design service valuation vs their global fabless peers

Company	Ticker	Local Price 7/17/2020	Mkt Cap (US$mn)	Ent. Value (US$mn)	Range	P/E Multiple 2020	P/E Multiple 2021	EV/EBITDA 2020	EV/EBITDA 2021	EV/Sales 2020	EV/Sales 2021	P/B Multiple 2020	P/B Multiple 2021	ROE 2020	ROE 2021
IC design service															
Global Unichip	3443.TW	$284.00	$1,291	$1,173	156.0-323.5	70.9	33.0	32.1	19.0	2.8	2.3	8.7	7.4	12.3	22.5
Alchip	3661.TW	$480.00	$999	$888	93.0-575.0	31.0	22.9	11.5	9.4	4.0	3.0	7.2	6.0	23.3	26.1
Faraday	3035.TW	$48.95	$412	$412	29.2-63.5	29.7	23.6	NM	NM	NM	NM	2.3	2.2	7.7	9.3
IC design service Median:						**31.0**	**23.6**	**21.8**	**14.2**	**3.4**	**2.7**	**7.2**	**6.0**	**12.3**	**22.5**
IC design service Mean:						**43.9**	**26.5**	**21.8**	**14.2**	**3.4**	**2.7**	**6.1**	**5.2**	**14.4**	**19.3**
Taiwan Fabless															
Mediatek	2454.TW	$607.00	$32,717	$26,969	274.0-661.0	30.0	20.4	18.3	12.1	2.7	2.1	3.1	2.8	10.3	14.0
Novatek	3034.TW	$262.00	$5,408	$4,649	152.0-285.5	17.3	16.2	12.2	11.1	2.0	1.9	4.4	4.2	25.7	25.7
Realtek	2379.TW	$342.50	$5,934	$4,906	162.0-367.5	23.6	19.2	16.9	13.6	2.2	1.9	5.9	5.3	25.0	27.4
Egis	6462.TWO	$196.50	$476	$386	121.5-314.0	14.1	12.2	8.6	7.2	1.6	1.3	4.5	4.0	31.5	32.7
Elan	2458.TW	$139.50	$1,438	$1,255	70.0-144.0	17.4	16.7	11.4	11.8	3.2	3.2	5.2	5.0	30.0	30.3
Global Unichip	3443.TW	$284.00	$1,291	$1,173	156.0-323.5	70.9	33.0	32.1	19.0	2.8	2.3	8.7	7.4	12.3	22.5
Himax	HIMX	$3.81	$656	$765	1.8-5.1	47.6	19.5	20.1	11.6	1.0	0.8	1.5	1.4	3.1	7.1
Parade	4966.TWO	$1,075.00	$2,918	$2,554	513.0-1135.0	29.3	24.0	22.6	18.3	5.8	5.0	6.6	5.7	22.6	23.6
Silergy	6415.TW	$1,735.00	$5,426	$5,426	594.0-2015.0	49.2	38.3	45.6	35.1	11.9	9.6	9.1	7.7	19.6	21.9
Taiwan Fabless Median:						**29.3**	**19.5**	**18.3**	**12.1**	**2.7**	**2.1**	**5.2**	**5.0**	**25.0**	**25.7**
Taiwan Fabless Mean:						**29.9**	**21.9**	**20.5**	**16.0**	**4.8**	**4.1**	**6.2**	**5.5**	**22.7**	**25.5**
China Fabless															
Goodix	603160.SS	$215.56	$14,068	$13,328	142.6-373.3	58.1	57.1	54.8	51.2	12.2	11.6	13.1	10.6	22.6	18.6
Will Semi	603501.SS	$208.16	$25,689	#VALUE!	60.3-249.7	64.9	39.5	38.0	25.5	8.9	6.4	15.2	10.5	23.4	26.7
Wingtech	600745.SS	$130.00	$20,882	$22,909	34.8-166.3	49.5	34.7	26.7	21.0	2.4	1.8	6.1	5.2	15.3	16.8
Montage	688008.SS	$96.85	$15,637	$14,585	58.3-117.6	92.8	69.3	95.3	65.8	45.2	33.7	13.5	11.7	15.2	17.6
Gigadevice	603986.SS	$243.00	$16,348	$16,080	61.6-304.4	102.1	98.4	89.6	81.7	22.5	18.4	11.0	9.9	10.4	10.1
Maxscend	300782.SZ	$465.30	$11,969	$11,829	114.5-521.9	102.0	73.0	87.0	60.6	34.6	24.8	34.9	25.0	34.8	36.2
SG Micro	300661.SZ	$335.17	$7,445	$7,323	63.0-390.8	205.4	138.5	192.9	127.4	48.0	33.4	39.4	31.7	20.7	23.7
NavInfo	002405.SZ	$18.50	$5,186	$4,981	13.3-21.4	106.9	70.3	66.5	50.3	13.8	10.9	4.5	4.2	4.7	5.8
China Fabless Median:						**97.4**	**69.8**	**76.8**	**55.9**	**18.2**	**15.0**	**13.3**	**10.6**	**18.0**	**18.1**
China Fabless Mean:						**97.7**	**72.6**	**81.3**	**60.4**	**23.5**	**17.6**	**17.2**	**13.6**	**18.4**	**19.4**

Source: Company data, The BLOOMBERG PROFESSIONAL™ service, Credit Suisse estimates

Alchip is currently trading at 34x/25x 2020/2021 P/E, vs its peers' average of 39x/27x, on the back of its healthy growth outlook in the next few years with modest OpM expansion. Its healthy project pipeline in the China CPU and global AI markets should support its sales growth, with some operating leverage and ROE improvement over the next few years.

We also used CS HOLT®, a CS valuation tool that derives a stock price based on a company's cash flow return on investment (CFROI®) and asset growth. We would note the valuation tool warrants an NT$657 share price, based on our modelled sales growth, margin assumptions and investment plans through 2022. The figure above shows our key assumptions.

Figure 133: Alchip's CS HOLT valuation

ALCHIP TECHNOLOGIES LIMITED (3661)

Semiconductors
Market Cap: 30.6 TWD

Price: 504.00 (15 Jul, 2020)
Warranted Price: 656.73 TWD (+30%)

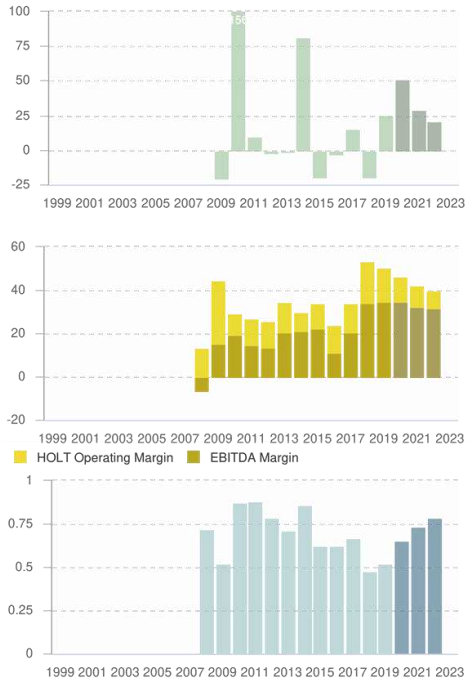
Sales, Margins & Turns Inputs

	2019	2020	2021	2022
Sales Growth %	25.5	51.0	29.1	20.5
EBITDA %	34.6	34.8	32.2	31.7
Effective Tax Rate %	17.5	21.2	21.1	21.2
Asset Turns	0.53	0.65	0.73	0.79
CFROI %	13.8	17.4	18.3	19.2
Real Asset Growth %	13.2	21.4	14.5	9.6
Discount Rate	5.60	5.73		

Warranted Valuation

Warranted Valuation	Amount (MM)	Per Share
+ PV Cash Flow Existing Assets	6,758	111.25
+ NPV Cash Flow Future Investments	32,067	527.90
+ Market Value Investments	NA	0
Total Economic Value	38,824	639.15
- Market Value of Debt & Equivalents	123	2.02
- Market Value of Minority Interest	0	0
Partial Year Adjustment	1,191	19.60
Warranted Equity Value	**39,892**	**656.73**
Winddown Value/Share		**109.23**
Winddown Ratio		4.61
Shares Outstanding	61	upside +30%

Sales, Margins & Turns



Note: North American companies only. Metrics shown are gross investment base weighted. Warranted valuation figures in millions of TWD

Source: Company data, Credit Suisse estimates

Profile of Alchip's senior management

Kinying Kwan—Chairman. Mr. Kwan is the Chairman and Founder of Alchip. Prior to Alchip, he worked at Altius Solutions/Simplex Solutions, Cirrus Logic Mass Storage Division, Tandem. Mr. Kwan holds a bachelor degree in Computer Engineering from the University of Illinois.

Johnny Shen—President & CEO. Mr. Shen is the President and CEO of Alchip. Prior to joining Alchip, he worked at the same division as Kinying Kwan in Altius Solutions/Simplex Solutions of Cadence. Mr. Shen holds a bachelor degree in Electrical Engineering from UCLA (University of California, Los Angeles).

Daniel Wang—CFO. Mr. Wang is the CEO of Alchip. Prior to joining in Alchip, he worked at Fubon Securities Investment Services. Mr. Wang holds an MBA degree from the Zicklin School of Business, CUNY Baruch College.

Andy Lin—GM of China. Mr. Lin is the GM of Alchip's China business. Prior to joining Alchip, he worked at Logitech Electronics. Mr. Lin holds MBA degree from the Said Business School, University of Oxford.

Junichirou Hosaka—GM of Japan Business Unit. Mr. Hosaka is in charge of Alchip's Japan business. Prior to joining Alchip, he worked in the Verisity Design division of Inno Micro. Mr. Hosaka holds a bachelor degree in Economics from Yokohama National University.

Hiroyuki Furuzono—Deputy GM of Japan Business Unit. Mr. Furuzono is the deputy GM of Alchip's Japan business. Prior to joining Alchip, Mr. Furuzono worked at Cadence and Innotech. He holds a bachelor degree in Engineering Science from Waseda University.

Leo Cheng—VP of SoC Design Engineering. Mr. Cheng is the vice president of SoC design engineering of Alchip. Prior to joining Alchip, he worked at Cirrus Logic and Stream Machine. Mr. Cheng holds a master degree in Electrical Engineering from the University of Southern California.

Key risks to our OUTPERFORM rating

- **Macro uncertainty leads to slower semiconductor investment.** We believe the global macro uncertainty triggered by COVID-19 could lead to a more conservative investment approach by the IC design service companies' customers as they could push out the semiconductor projects, which is witnessed in GUC's business slowdown in 2009, 2011-13 along with global economy correction.
- **Slower local CPU penetration in China.** Although China CPU fabless have made good progress on the chipset development in the past 5 years and could replace Intel and AMD's CPU in the mission critical applications. However, we believe the performance and ecosystem support for most of the solutions developed by local fabless are still lagging their overseas' peers. Although Phytium compared with other local peers have better technology roadmap (PC CPU on 16nm and server CPU on 7nm), ARM's ecosystem support (vs. Loongson's MIPS architecture and Sunway's own architecture) and technology control with permanent license from ARM (vs. Zhaoxin and Hygon's x86 architecture), the local CPU penetration could be slower than expected if the feedback on the China-made CPU and operating system from the users in the government and SOE is not as good, leading to the adoption rate lower than our expectation (30% adoption for PC and low-to-mid-single-digits for server adopted by China government and SOE in the next few years).
- **Timing uncertainty in AI chipset development.** With most of the projects in AI ASIC started by the start-ups and system companies, the chipset development could take longer than expected if the spec is change or the performance doesn't meet the requirement, risking the timing of revenue recognition for NRE milestone. For the turnkey business, the timing of the production ramp and volume demand change could also impact the IC design service companies' revenue expectation.
- **Customers shift to foundry direct business model.** We note the risk is lower for IC design service companies to lose their AI ASIC customers as the size of the each project and the IC design team in the start-ups and system houses is usually smaller, with the chipsets only for customised and more niche applications (vs cryptocurrency mining ASIC widely adopted in the mining activity in large scale) so they would still need support from IC design service companies. We believe foundries also prefer to work with IC design service companies for the smaller start-ups and system houses, as it allows them to plan capacity in the advanced nodes more easily after experiencing the volatility in cryptocurrency chipset demand in 2017-18. Examples include Cambricon, an AI chipset start-up in China which has filed for IPO in the China A-share market, still working with Broadcom; while Brainchip, focusing on neuromorphic SoC and already listed in Australia, is still working with Socionext in Japan on the back-end design.

  For the China CPU projects, we believe the risk is also low for them to move to foundry direct business model, as most of the IC design team in local CPU fabless is still relatively small and lacks experience in the leading edge technology design, while the penetration in the domestic market is also low. From the foundry perspective, we believe the political concern may also prevent them from releasing the leading edge reference design and PDK to the government-backed companies, leaving room for the IC design service companies.

Alchip financials

Figure 134: Alchip's income statement summary

Summary Income Statement	1Q20E	2Q20E	3Q20E	4Q20E	1Q21E	2Q21E	3Q21E	4Q21E	2015	2016	2017	2018	2019F	2020F	2021F	2022F
Net Sales	**1,520**	**1,644**	**1,704**	**1,849**	**2,050**	**2,190**	**2,221**	**2,210**	**3,786**	**3,691**	**4,266**	**3,451**	**4,332**	**6,717**	**8,671**	**9,860**
Sequential Change	*5.6%*	*8.1%*	*3.7%*	*8.5%*	*10.9%*	*6.8%*	*1.4%*	*-0.5%*								
Y/Y Change	*36.1%*	*90.0%*	*87.3%*	*28.4%*	*34.8%*	*33.3%*	*30.3%*	*19.5%*	*-19.3%*	*-2.5%*	*15.6%*	*-19.1%*	*25.5%*	*55.1%*	*29.1%*	*13.7%*
Cost of Goods Sold	1,016	1,084	1,101	1,183	1,363	1,456	1,457	1,436	2,963	3,203	3,065	2,159	2,721	4,384	5,713	6,481
Gross Profits	**504**	**560**	**603**	**665**	**687**	**734**	**764**	**773**	**822**	**488**	**1,201**	**1,291**	**1,611**	**2,333**	**2,958**	**3,379**
Gross Margin	***33.2%***	***34.1%***	***35.4%***	***36.0%***	***33.5%***	***33.5%***	***34.4%***	***35.0%***	***21.7%***	***13.2%***	***28.2%***	***37.4%***	***37.2%***	***34.7%***	***34.1%***	***34.3%***
Operating Exp. Promotion	35	37	37	38	41	44	44	43	97	87	124	142	138	147	172	185
% of Sales	*2.3%*	*2.2%*	*2.2%*	*2.1%*	*2.0%*	*2.0%*	*2.0%*	*2.0%*	*2.6%*	*2.4%*	*2.9%*	*4.1%*	*3.2%*	*2.2%*	*2.0%*	*1.9%*
Operating Exp. Administrative	83	87	88	91	97	104	106	103	173	186	235	207	354	350	409	442
% of Sales	*5.5%*	*5.3%*	*5.2%*	*4.9%*	*4.7%*	*4.7%*	*4.8%*	*4.6%*	*4.6%*	*5.1%*	*5.5%*	*6.0%*	*8.2%*	*5.2%*	*4.7%*	*4.5%*
Operating Expense R&D	176	183	186	192	203	218	222	215	412	424	522	620	686	737	859	926
% of Sales	*11.6%*	*11.1%*	*10.9%*	*10.4%*	*9.9%*	*10.0%*	*10.0%*	*9.7%*	*10.9%*	*11.5%*	*12.2%*	*18.0%*	*15.8%*	*11.0%*	*9.9%*	*9.4%*
Total Operating Exp	294	307	312	321	340	366	372	361	682	698	881	970	1,178	1,234	1,439	1,553
Income from Operations	**210**	**253**	**292**	**344**	**347**	**367**	**392**	**412**	**141**	**(210)**	**320**	**322**	**433**	**1,099**	**1,519**	**1,826**
% of Sales	***13.8%***	***15.4%***	***17.1%***	***18.6%***	***16.9%***	***16.8%***	***17.7%***	***18.7%***	***3.7%***	***-5.7%***	***7.5%***	***9.3%***	***10.0%***	***16.4%***	***17.5%***	***18.5%***
Depreciation	198	198	198	198	198	198	198	198	533	478	395	647	490	791	791	791
Amortization	95	107	119	127	124	115	118	121	164	130	106	139	439	448	478	479
EBITDA	**503**	**557**	**608**	**670**	**668**	**680**	**708**	**731**	**838**	**399**	**821**	**1,108**	**1,362**	**2,338**	**2,787**	**3,096**
% of Sales	*33.1%*	*33.9%*	*35.7%*	*36.2%*	*32.6%*	*31.0%*	*31.9%*	*33.1%*	*22.1%*	*10.8%*	*19.3%*	*32.1%*	*31.4%*	*34.8%*	*32.1%*	*31.4%*
Non Operating Income	18	22	25	27	24	23	24	25	27	8	39	13	92	92	97	98
Net Investment Income/ (Loss)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pretax Income	**228**	**275**	**317**	**371**	**371**	**391**	**417**	**437**	**168**	**(201)**	**359**	**335**	**525**	**1,191**	**1,615**	**1,924**
% of Sales	*15.0%*	*16.7%*	*18.6%*	*20.1%*	*18.1%*	*17.8%*	*18.8%*	*19.8%*	*4.4%*	*-5.5%*	*8.4%*	*9.7%*	*12.1%*	*17.7%*	*18.6%*	*19.5%*
Income Taxes Exp. /(Gains)	53	56	65	76	86	80	85	90	39	10	50	77	92	251	342	407
Tax Rate	*23.5%*	*20.5%*	*20.5%*	*20.5%*	*23.3%*	*20.5%*	*20.5%*	*20.5%*	*23.4%*	*-5.0%*	*14.0%*	*23.1%*	*17.5%*	*21.1%*	*21.1%*	*21.2%*
Net Income before Extraordinaries	**174**	**218**	**252**	**295**	**284**	**311**	**331**	**348**	**129**	**(211)**	**309**	**257**	**434**	**940**	**1,274**	**1,516**
Minority Interest	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**(0)**	**0**	**0**	**0**
Extraordinaries	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Income after Extraordinaries	**174**	**218**	**252**	**295**	**284**	**311**	**331**	**348**	**129**	**(211)**	**309**	**257**	**434**	**940**	**1,274**	**1,516**
% of Sales	*11.5%*	*13.3%*	*14.8%*	*16.0%*	*13.9%*	*14.2%*	*14.9%*	*15.7%*	*3.4%*	*-5.7%*	*7.2%*	*7.5%*	*10.0%*	*14.0%*	*14.7%*	*15.4%*
Preferred dividends	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Income after Preferred Dividends	**174**	**218**	**252**	**295**	**284**	**311**	**331**	**348**	**129**	**(211)**	**309**	**257**	**434**	**940**	**1,274**	**1,516**
Dividend to Common Share Holders	-	-	212	-	-	-	423	-	39	30	-	66	92	212	423	637
Retained Earnings	***174***	***218***	***39***	***295***	***284***	***311***	***(92)***	***348***	***90***	***(241)***	***309***	***192***	***342***	***727***	***851***	***879***
% of Sales	*11.5%*	*13.3%*	*2.3%*	*16.0%*	*13.9%*	*14.2%*	*-4.1%*	*15.7%*	*2.4%*	*-6.5%*	*7.2%*	*5.6%*	*7.9%*	*10.8%*	*9.8%*	*8.9%*
GAAP EPS (NT$)	**2.87**	**3.60**	**4.15**	**4.87**	**4.69**	**5.12**	**5.46**	**5.73**	**2.05**	**-3.44**	**5.08**	**4.20**	**7.22**	**15.50**	**21.00**	**25.00**
Pro Forma EPS (NT$)	**2.87**	**3.60**	**4.15**	**4.87**	**4.69**	**5.12**	**5.46**	**5.73**	**2.05**	**-3.44**	**5.08**	**4.20**	**7.22**	**15.50**	**21.00**	**25.00**
Share Count (actual)	61	61	61	61	61	61	61	61	62	61	61	61	60	61	61	61
Share Count (weighted)	61	61	61	61	61	61	61	61	63	61	61	61	60	61	61	61

Source: Company data, Credit Suisse estimates

Figure 135: Alchip's balance sheet summary

NT$ mn	1Q20E	2Q20E	3Q20E	4Q20E	1Q21E	2Q21E	3Q21E	4Q21E	2015	2016	2017	2018	2019	2020	2021	2022
Cash, Cash Equivalent	2,227	2,429	2,422	2,734	2,861	3,126	2,990	3,295	958	974	1,719	1,765	2,480	2,734	3,295	3,930
Inventories	449	518	581	605	668	731	740	722	234	164	61	281	582	605	722	829
Account receivables	1,417	1,475	1,496	1,540	1,814	1,913	1,927	1,911	819	981	412	671	898	1,540	1,911	2,206
Other current assets	156	169	175	190	211	225	229	227	571	148	141	167	148	190	227	261
Total current asset	**4,250**	**4,591**	**4,674**	**5,069**	**5,554**	**5,995**	**5,885**	**6,155**	**2,582**	**2,266**	**2,332**	**2,884**	**4,108**	**5,069**	**6,155**	**7,226**
LT investment	354	354	354	354	354	354	354	354	710	649	394	319	354	354	354	354
Fixed Assets	442	494	547	599	651	704	756	808	445	217	269	317	389	599	808	1,018
Intangible Assets	222	222	222	222	222	222	222	222	144	117	87	147	222	222	222	222
Other Assets	151	151	151	151	151	151	151	151	35	39	33	51	151	151	151	151
Total Non-Current Assets	**1,169**	**1,222**	**1,274**	**1,326**	**1,379**	**1,431**	**1,483**	**1,536**	**1,333**	**1,022**	**784**	**834**	**1,117**	**1,326**	**1,536**	**1,745**
Total assets	**5,419**	**5,813**	**5,948**	**6,396**	**6,933**	**7,426**	**7,368**	**7,691**	**3,915**	**3,289**	**3,116**	**3,717**	**5,225**	**6,396**	**7,691**	**8,971**
Accounts payable	357	414	452	465	524	571	575	562	105	286	47	136	415	465	562	646
ST interest bearing Liabilities	15	15	15	15	15	15	15	15	552	134	42	-	15	15	15	15
Other current liabilities	1,463	1,581	1,640	1,779	1,972	2,107	2,137	2,126	431	311	269	633	1,385	1,779	2,126	2,443
Total current liabilities	**1,836**	**2,011**	**2,107**	**2,259**	**2,512**	**2,694**	**2,728**	**2,703**	**1,088**	**731**	**358**	**769**	**1,816**	**2,259**	**2,703**	**3,104**
LT liabilities	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other LT liabilities	108	108	108	108	108	108	108	108	-	-	43	28	108	108	108	108
Total Long Term liabilities	**108**	**108**	**108**	**108**	**108**	**108**	**108**	**108**	**-**	**-**	**43**	**28**	**108**	**108**	**108**	**108**
Total Liabilities	**1,943**	**2,119**	**2,215**	**2,366**	**2,619**	**2,802**	**2,836**	**2,811**	**1,088**	**731**	**401**	**797**	**1,923**	**2,366**	**2,811**	**3,212**
Share Capital	606	606	606	606	606	606	606	606	616	607	610	598	606	606	606	606
Share Premium & Other Reserves	1,535	1,535	1,535	1,535	1,535	1,535	1,535	1,535	1,392	1,388	1,425	1,456	1,535	1,535	1,535	1,535
Retained earnings	1,339	1,557	1,597	1,892	2,176	2,487	2,395	2,743	663	421	730	822	1,165	1,892	2,743	3,622
Preferred Stocks	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-
Treasury Stock	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-
Other Equity	-4	-4	-4	-4	-4	-4	-4	-4	157	141	(51)	45	(4)	(4)	(4)	(4)
Total Equity	**3,476**	**3,694**	**3,734**	**4,029**	**4,313**	**4,624**	**4,532**	**4,880**	**2,827**	**2,558**	**2,714**	**2,921**	**3,302**	**4,029**	**4,880**	**5,759**
Minority Interest	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Total Liabilities & Equity	**5,419**	**5,813**	**5,948**	**6,396**	**6,933**	**7,426**	**7,368**	**7,691**	**3,915**	**3,289**	**3,116**	**3,717**	**5,225**	**6,396**	**7,691**	**8,971**

Source: Company data, Credit Suisse estimates

Figure 136: Alchip profitability ratios

NT$ mn	1Q20E	2Q20E	3Q20E	4Q20E	1Q21E	2Q21E	3Q21E	4Q21E	2015	2016	2017	2018	2019	2020	2021	2022
Return on Equity (ROE)	5.0%	5.9%	6.7%	7.3%	6.6%	6.7%	7.3%	7.1%	4.6%	NM	11.4%	8.8%	13.1%	23.3%	26.1%	26.3%
Return on Assets (ROA)	3.2%	3.8%	4.2%	4.6%	4.1%	4.2%	4.5%	4.5%	3.3%	NM	9.9%	6.9%	8.3%	14.7%	16.6%	16.9%
Return on Net Assets (RONA)	5.5%	6.5%	7.1%	8.1%	7.0%	7.2%	7.6%	7.9%	5.7%	NM	30.8%	15.7%	18.1%	28.4%	29.0%	30.1%
Return on invested capital									3.2%	-6.9%	9.4%	7.5%	8.9%	17.7%	21.1%	21.7%
Return on Sales	11.5%	13.3%	14.8%	16.0%	13.9%	14.2%	14.9%	15.7%	3.4%	NM	7.2%	7.5%	10.0%	14.0%	14.7%	15.4%
Efficiency Ratios																
Asset Turns	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.1	1.0	1.1	1.4	0.9	0.8	1.1	1.1	1.1
Receivables turns (annualized)	4.3	4.5	4.6	4.8	4.5	4.6	4.6	4.6	4.6	3.8	10.4	5.1	4.8	4.4	4.5	4.5
Days sales outstanding (DSO)	85.0	81.9	80.1	76.0	80.8	79.7	79.1	78.9	78.9	97.0	35.2	70.9	75.7	83.7	80.4	81.7
Inventory turnover (annualized)	9.0	8.4	7.6	7.8	8.2	8.0	7.9	8.0	12.7	19.6	50.6	7.7	4.7	7.2	7.9	7.8
Days of inventory	40.4	43.6	48.1	46.7	44.7	45.8	46.3	45.9	28.8	18.7	7.2	47.5	78.0	50.4	46.1	46.7
Payables turnover (annualized)	11.4	10.5	9.8	10.2	10.4	10.2	10.1	10.2	28.3	11.2	65.6	15.9	6.6	9.4	10.2	10.0
Days of Payables	32.1	34.9	37.4	35.8	35.1	35.8	36.0	35.7	12.9	32.6	5.6	22.9	55.7	38.7	35.9	36.4
Cash conversion cycle	93.3	90.7	90.8	86.9	90.4	89.7	89.4	89.1	94.8	83.1	36.9	95.6	98.0	95.4	90.7	92.0
Working Capital	$187	$152	$145	$76	$182	$175	$167	$157	$535	$561	$255	$351	-$188	$76	$157	$192
(Increase)/Decrease in working capital	(375)	35	7	69	(105)	7	8	10	138	(26)	306	(96)	539	(264)	(81)	(35)
Per Share Values																
Book Value per common share	$57.32	$60.92	$61.57	$66.43	$71.12	$76.24	$74.73	$80.46	$44.90	$41.60	$44.70	$47.69	$55.02	$66.43	$80.46	$94.96
Tangible Book Value per common share																
Cash per common share	$42.57	$45.89	$45.78	$50.93	$53.01	$57.38	$55.14	$60.17	$26.50	$26.40	$34.80	$34.01	$47.24	$50.93	$60.17	$70.64
Net Cash per common share	$42.31	$45.63	$45.53	$50.67	$52.76	$57.13	$54.89	$59.92	$17.73	$24.22	$34.11	$34.01	$46.98	$50.67	$59.92	$70.39

Source: Company data, Credit Suisse estimates

Figure 137: Alchip's cash flow summary

(NT$ mn)	1Q20E	2Q20E	3Q20E	4Q20E	1Q21E	2Q21E	3Q21E	4Q21E	2015	2016	2017	2018	2019	2020	2021	2022
Net income	**174**	**218**	**252**	**295**	**284**	**311**	**331**	**348**	**129**	**(211)**	**309**	**257**	**434**	**940**	**1,274**	**1,516**
Depreciation & Amortization	293	304	316	325	322	312	316	318	697	608	501	786	929	1,239	1,268	1,270
Dec (inc)-A/R	(519)	(58)	(21)	(43)	(275)	(98)	(14)	16	(175)	(163)	569	(259)	(227)	(641)	(371)	(295)
Dec (inc)-Inventory	132	(69)	(62)	(25)	(62)	(63)	(9)	18	(10)	70	103	(221)	(300)	(24)	(117)	(107)
Inc (Dec)-A/P	(58)	57	38	13	59	48	4	(14)	(23)	181	(239)	89	279	50	97	84
LT investment loss (gain)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Investment disposal loss (gain)	-	-	-	-	-	-	-	-	2	34	8	2	0	-	-	-
Others	69	106	52	124	173	120	27	(10)	(2)	16	(8)	365	550	351	310	283
Operating Cash Flow	**92**	**558**	**575**	**689**	**501**	**629**	**655**	**676**	**617**	**535**	**1,242**	**1,020**	**1,664**	**1,915**	**2,461**	**2,751**
Sale(Pur) of ST Inv.									(718)	46	51	159	(107)	-	-	-
Sale(Pur) of LT Inv.									83	-	-	(591)	605	-	-	-
Sale of FA									5	0	0	0	0	-	-	-
Capital Spending	**(250)**	**(250)**	**(250)**	**(250)**	**(250)**	**(250)**	**(250)**	**(250)**	**(502)**	**(295)**	**(475)**	**(712)**	**(511)**	**(1,000)**	**(1,000)**	**(1,000)**
Others	(95)	(107)	(119)	(127)	(124)	(115)	(118)	(121)	(309)	210	(82)	(114)	(282)	(448)	(478)	(479)
Investing Cash Flow	**(345)**	**(357)**	**(369)**	**(377)**	**(374)**	**(365)**	**(368)**	**(371)**	**(1,440)**	**(39)**	**(505)**	**(1,258)**	**(295)**	**(1,448)**	**(1,478)**	**(1,479)**
Inc (Dec) of Debt	-	-	-	-	-	-	-	-	552	(417)	(92)	(42)	15	-	-	-
Bonds Issued (Redeemed)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Treasury Stock Dec(Inc)	-	-	-	-	-	-	-	-	(113)	(22)	-	(158)	-	-	-	-
Proceed from new issue	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dividend paid	-	-	(212)	-	-	-	(423)	-	(39)	(30)	-	(64)	(91)	(212)	(423)	(637)
Others	0	(0)	-	-	0	(0)	0	0	3	10	29	40	(1)	0	0	-
Financing Cash Flow	**0**	**(0)**	**(212)**	**-**	**0**	**(0)**	**(423)**	**0**	**402**	**(459)**	**(64)**	**(224)**	**(76)**	**(212)**	**(423)**	**(637)**
Exchange influence									23	(22)	(85)	43	(58)	-	-	-
Change in Cash Flow	**(253)**	**201**	**(6)**	**312**	**127**	**265**	**(136)**	**305**	**(398)**	**16**	**588**	**(420)**	**1,235**	**254**	**561**	**635**
Cash equivalent - beginning	2,377	2,227	2,429	2,422	2,734	2,861	3,126	2,990	1,357	1,144	711	688	958	1,079	883	912
Cash equivalent - end	2,227	2,429	2,422	2,734	2,861	3,126	2,990	3,295	958	974	1,562	1,610	2,377	2,227	3,295	3,549
Operating cash per share	**$1.52**	**$9.20**	**$9.48**	**$11.36**	**$8.26**	**$10.38**	**$10.81**	**$11.14**	**$9.80**	**$8.71**	**$20.46**	**$16.65**	**$27.74**	**$31.57**	**$40.58**	**$45.36**
FCF per share	**-$2.60**	**$5.08**	**$5.36**	**$7.24**	**$4.14**	**$6.26**	**$6.68**	**$7.02**	**$1.83**	**$3.91**	**$12.65**	**$5.02**	**$19.23**	**$15.08**	**$24.10**	**$28.87**

Source: Company data, Credit Suisse estimates

CREDIT SUISSE

GUC

Turnkey volume uncertainty outweighs the NRE opportunity in AI and 5G

3443.TW

Target price (12M, NT$)
250.00
Neutral[V]

Semiconductor Devices

- **IC design service provider backed by TSMC's technology leadership.** We initiate coverage on GUC with a NEUTRAL rating and a target price of NT$250 based on 28x 2021E P/E. GUC is the largest IC design service provider in Taiwan, with a strong technology and capacity support across mature to advanced nodes from TSMC who owns 35% of the company. We expect GUC's sales to see a solid growth of 18% CAGR over 2019-22, with a GM of 30%, mainly driven by its customers' AI and 5G investments.
- **Strategy optimised for application diversification but not growth potential.** Compared with Alchip's focus on the high-performance computing business, GUC, as a TSMC investment, has a more balanced application mix, with 38% from computing (AI, HPC, BMC, SSD controller), 39% from consumer (drone, TV, surveillance camera, game console), 11% from communication (5G, networking) and 12% from others (solar). We expect GUC's diversification strategy to continue, forcing it to allocate resource in areas with less growth (consumer and solar) and limit its growth opportunity in HPC.
- **AI and 5G NRE growing, but volume production still uncertain.** GUC's sales have almost doubled from 2013 to 2018, mainly driven by the surge in crypto demand, but was also dragged by lower bitcoin pricing in 2019, with sales down 20% YoY. We expect the projects related to AI and 5G to be the main driver, with key ones including ZTE's 5G multiband networking chipset on 7nm, Alibaba and start-ups' AI projects, supporting growth reacceleration from 2H20 following slower QoQ trend in 1H20. Despite a healthy outlook from the NRE project pipeline, we believe the lack of production scale compared with Alchip's China CPU projects will limit GUC's operating leverage.
- **Stock at the upper half already values the HPC opportunity.** We model GUC's EPS at NT$4.00/NT$8.60 for 2020/21E, factoring in the company's improving growth outlook from AI and 5G investment but less operating leverage. Our target price of NT$250 is based on 28x 2021E P/E. The company's stock is at 51x/31x 2020/2021E CS estimates, at the upper half of its long-term range of 15x-35x P/E. We see the premium valuation also reflecting investors' high expectations for solid growth, though any AI project delay in milestone or in production could drag the sentiment.

Price (17 Jul 20, NT$)	284.00
Upside/downside (%)	-12.0
Mkt cap (NT$/US$ mn)	38,059 / 1,291
Enterprise value (NT$ mn)	35,678
Number of shares (mn)	134.01
Free float (%)	73.7
52-wk price range (NT$)	324-156
ADTO-6M (US$ mn)	24.5

[V] = Stock Considered Volatile (see Disclosure Appendix)

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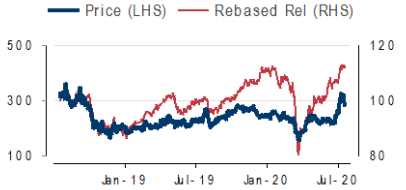
Financial and valuation metrics

Year	12/18A	12/19E	12/20E	12/21E
Revenue (NT$ mn)	13,459.8	10,710.1	13,038.6	15,775.0
EBITDA (NT$ mn)	1,509.6	1,295.3	1,132.1	1,912.8
EBIT (NT$ mn)	1,096.4	697.2	536.7	1,316.2
Net profit (NT$ mn)	988.2	633.5	536.6	1,152.9
EPS (CS adj.) (NT$)	7.37	4.73	4.0	8.6
Chg. from prev. EPS (%)	n.a	n.a	n.a	n.a
Consensus EPS (NT$)	n.a.	4.37	6.26	9.14
EPS growth (%)	15.6	(35.9)	(15.3)	114.9
P/E (x)	38.5	60.1	70.9	33.0
Dividend yield (%)	1.8	1.8	1.8	1.8
EV/EBITDA (x)	22.6	27.4	31.6	18.7
P/B (x)	8.72	8.82	8.7	7.43
ROE (%)	23.5	14.6	12.4	24.3
Net debt/equity (%)	(89.5)	(58.9)	(51.4)	(45.4)

Source: Company data, Refinitiv, Credit Suisse estimates

Share price performance

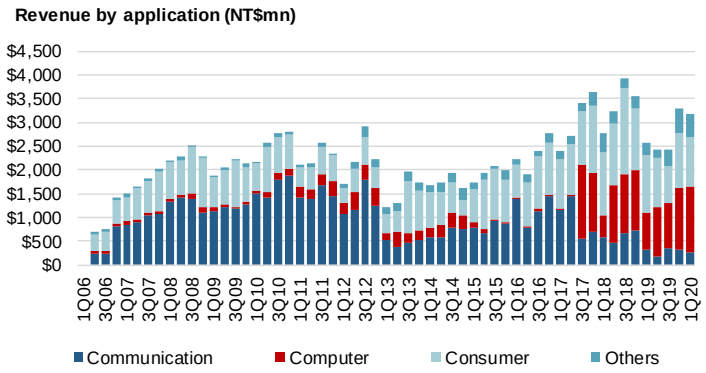


The price relative chart measures performance against the TAIWAN SE WEIGHTED INDEX which closed at 12,181.56 on 17/07/20. On 17/07/20 the spot exchange rate was NT$29.48/US$1

Performance	1M	3M	12M
Absolute (%)	28.8	16.6	27.1
Relative (%)	23.2	1.7	14.3

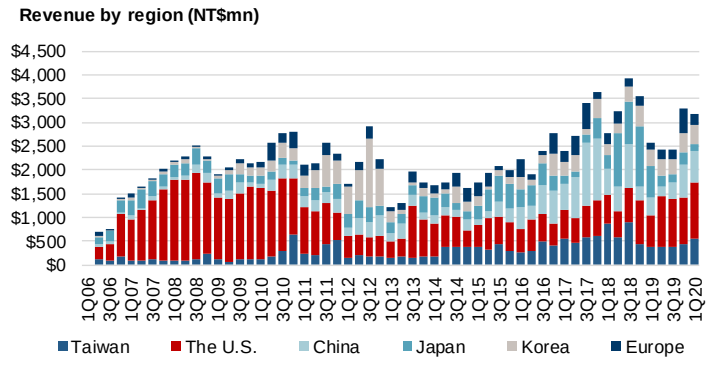
Focus chart and tables

Figure 138: GUC's growth in computing partially offset by slower communication and declining consumer



Source: Company data, Credit Suisse estimates

Figure 139: GUC's China business slowed down following cryptocurrency correction



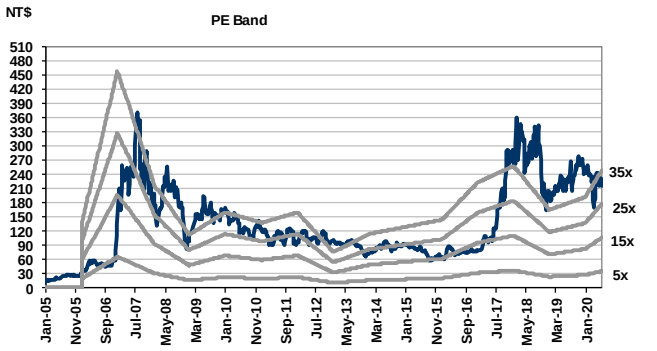
Source: Company data, Credit Suisse estimates

Figure 140: GUC's key projects and customers in 2020

GUC's sales by application	2019	Key projects in 2020	Major customers
Computer	38%	Cloud AI training and inference, HPC, BMC, SSD controller	U.S. and China internet companies and memory maekrs
Communication	11%	Wireless (5G), Wired (ethernet switch)	China 5G infrastructure supplier
Consumer	39%	TV SoC, surveillance camera, drone, game console	Japan and China customers
Others	12%	Solar	NM

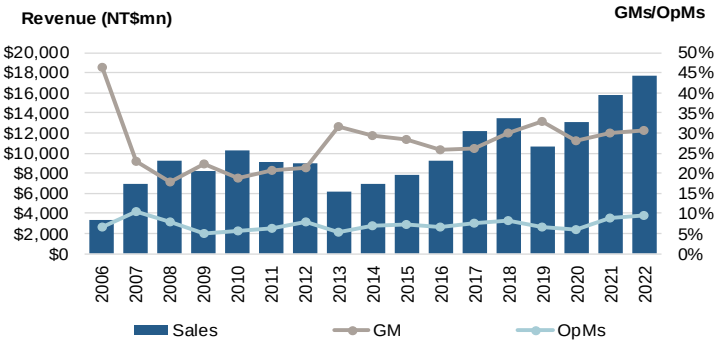
Source: Credit Suisse estimates

Figure 141: GUC's share at the upper half of its 15x-35x range



Source: Company data, Credit Suisse estimates

Figure 142: GUC should see better growth from AI and 5G though profitability will only be stable



Source: Company data, Credit Suisse estimates

Figure 143: GUC's 2Q20-3Q20 and 2020-21 estimates—CS vs street

	2Q20		3Q20		4Q20		2020		2021	
(NT$ mn)	CS	Street	CS	Street	CS	Street	CS	Street	CS	Street
Sales	**$2,927**	**$2,959**	**$3,301**	**$3,276**	**$3,641**	**$3,605**	**$13,039**	**$12,994**	**$15,775**	**$15,500**
Chg	*-7.7%*	*-6.7%*	*12.8%*	*11.9%*	*10.3%*	*10.1%*	*21.7%*	*21.0%*	*21.0%*	*19.3%*
GM (%)	**25.2%**	***29.6%***	**28.0%**	***31.3%***	**29.4%**	**32.1%**	**26.8%**	**29.8%**	**30.0%**	**30.7%**
OpM (%)	**1.9%**	**5.4%**	**4.8%**	**8.4%**	**6.8%**	**9.4%**	**4.1%**	**6.7%**	**8.3%**	**8.0%**
EPS (NT$)	**$0.27**	**$1.01**	**$1.16**	**$1.75**	**$1.83**	**$2.25**	**$4.00**	**$5.93**	**$8.60**	**$8.99**

Source: Company data, Credit Suisse estimates

GUC (3443.TW / 3443 TT)

Analyst: **Haas Liu**

Price (17 Jul 2020): **NT$284.00**

Target Price: **NT$250.00**

Rating: **Neutral**

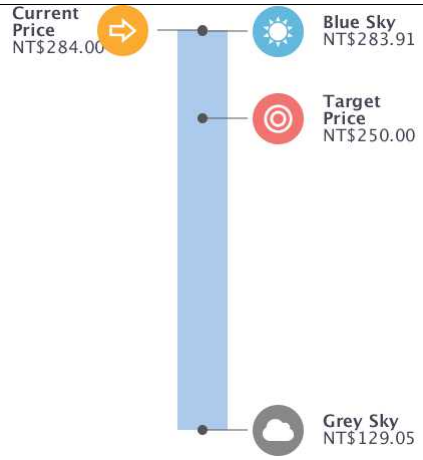
Income Statement (NT$ mn)	12/18A	12/19E	12/20E	12/21E
Sales revenue	**13,460**	**10,710**	**13,039**	**15,775**
Cost of goods sold	9,443	7,180	9,543	11,040
EBITDA	**1,510**	**1,295**	**1,132**	**1,913**
EBIT	**1,096**	**697**	**537**	**1,316**
Net interest expense/(inc.)	(27)	(22)	(640)	(640)
Recurring PBT	**1,135**	**783**	**661**	**1,423**
Profit after tax	**988**	**633**	**537**	**1,153**
Reported net profit	**988**	**633**	**537**	**1,153**
Net profit (Credit Suisse)	**988**	**633**	**537**	**1,153**
Balance Sheet (NT$ mn)	**12/18A**	**12/19E**	**12/20E**	**12/21E**
Cash & cash equivalents	3,906	2,542	2,247	2,325
Current receivables	910	1,418	1,566	1,800
Inventories	1,332	2,103	2,253	2,552
Other current assets	480	553	610	701
Current assets	**6,629**	**6,616**	**6,677**	**7,379**
Property, plant & equip.	1,089	982	1,639	2,296
Investments	0	0	0	0
Intangibles	288	412	412	412
Other non-current assets	104	330	330	330
Total assets	**8,109**	**8,341**	**9,058**	**10,418**
Current liabilities	**3,635**	**3,638**	**4,295**	**4,903**
Total liabilities	**3,743**	**4,028**	**4,684**	**5,293**
Total debt	0	0	0	0
Shareholders' equity	**4,366**	**4,313**	**4,374**	**5,125**
Minority interests	0	0	0	0
Total liabilities & equity	**8,109**	**8,341**	**9,058**	**10,418**
Cash Flow (NT$ mn)	**12/18A**	**12/19E**	**12/20E**	**12/21E**
EBIT	**1,096**	**697**	**537**	**1,316**
Net interest	0	0	0	0
Tax paid	(147)	(150)	(124)	(270)
Working capital	(571)	(973)	139	(271)
Other cash & non-cash items	(151)	533	881	960
Operating cash flow	**227**	**108**	**1,433**	**1,734**
Capex	(529)	(490)	(1,000)	(1,000)
Free cash flow to the firm	**(302)**	**(382)**	**433**	**734**
Investing cash flow	**(743)**	**(735)**	**(1,252)**	**(1,254)**
Equity raised	0	0	0	0
Dividends paid	(670)	(670)	(475)	(402)
Financing cash flow	**(670)**	**(727)**	**(475)**	**(402)**
Total cash flow	**(1,186)**	**(1,354)**	**(294)**	**78**
Adjustments	2	(11)	0	0
Net change in cash	**(1,184)**	**(1,365)**	**(294)**	**78**
Per share	**12/18A**	**12/19E**	**12/20E**	**12/21E**
Shares (wtd avg.) (mn)	134	134	134	134
EPS (Credit Suisse) (NT$)	**7.37**	**4.73**	**4.00**	**8.60**
DPS (NT$)	5.00	5.00	5.00	5.00
Operating CFPS (NT$)	1.69	0.81	10.69	12.94
Earnings	**12/18A**	**12/19E**	**12/20E**	**12/21E**
Growth (%)				
Sales revenue	10.7	(20.4)	21.7	21.0
EBIT	17.8	(36.4)	(23.0)	145.2
EPS	15.6	(35.9)	(15.3)	114.9
Margins (%)				
EBITDA	11.2	12.1	8.7	12.1
EBIT	8.1	6.5	4.1	8.3
Valuation (x)	**12/18A**	**12/19E**	**12/20E**	**12/21E**
P/E	38.5	60.1	70.9	33.0
P/B	8.72	8.82	8.70	7.43
Dividend yield (%)	1.8	1.8	1.8	1.8
EV/sales	2.5	3.3	2.7	2.3
EV/EBITDA	22.6	27.4	31.6	18.7
EV/EBIT	31.2	50.9	66.7	27.1
ROE analysis (%)	**12/18A**	**12/19E**	**12/20E**	**12/21E**
ROE	23.5	14.6	12.4	24.3
ROIC	(327.2)	50.6	22.4	43.3
Credit ratios	**12/18A**	**12/19E**	**12/20E**	**12/21E**
Net debt/equity (%)	(89.5)	(58.9)	(51.4)	(45.4)
Net debt/EBITDA (x)	(2.59)	(1.96)	(1.99)	(1.22)

Source: Company data, Refinitiv, Credit Suisse estimates

Company Background

Global Unichip (GUC) is a leading IC design service company. The company designs chispets 100% for its customers who don't have IC design capability and the goal is to reduce entry barriers and risks for chipset design and shorten the time to market.

Blue/Grey Sky Scenario



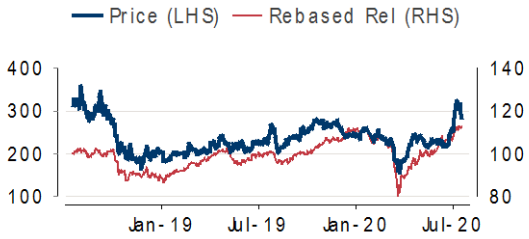
Our Blue Sky Scenario (NT$) **283.91**

Our blue sky scenario implies share price can be up to NT$283.91 on the back of faster than expected AI and 5G project development.

Our Grey Sky Scenario (NT$) **129.05**

Our grey Sky scenario implies share price can be at NT$129.05 if its customers fails to deliver on AI or 5G networking projects.

Share price performance



The price relative chart measures performance against the TAIWAN SE WEIGHTED INDEX which closed at 12,181.56 on 17-Jul-2020
On 17-Jul-2020 the spot exchange rate was NT$29.48/US$1

Turnkey volume uncertainty outweighs the opportunity in AI and 5G

GUC is a leading IC design service company in Taiwan founded in 1998. The company's business is to design chipsets 100% for its customers who do not have IC design capability and the goal is to reduce entry barriers and risks for chipset design and shorten the time to market. The company's target to enable more IC design for start-ups and system companies is complementary with TSMC who would benefit from growing customer and application base in addition to the company's existing IC design and IDM customers.

Figure 144: GUC's milestone

Date	Milestone
Jan-98	Founded under the name as Chuangyi Electronics Corporation
Jul-99	1st DSP core taped out
Dec-00	Completed validation down to 0.18um
Dec-04	Completed the 1st tape-out on 90nm
Mar-06	Completed 1st tape-out on 65nm
Nov-06	Listed on the Taiwan Stock Exchange
Jan-07	Completed the digital camera chipset project on 65nm
May-07	Completed the 1st tape-out on 45nm
Dec-07	Started mass production for TV SoC on 65nm
Jan-09	Completed the tape-out on 40nm for PCIe Gen2 PHY test chip
Aug-10	Helped its customers to develop 4G LTE baseband chip on 40nm with 3D SiP
Jan-13	Validated GPU/CPU platform on 28nm
Jul-13	Taped out a 20nm SoC test chip
Oct-14	Completed 1st production design on TSMC's 16FF+ process
Nov-14	Started Japan Design center
Jan-15	Developed networking chipset on TSMC's 16nm with Credo Semiconductor
Apr-15	Delivered PCIE Gen4 solution on 16nm with PLDA
Dec-15	Completed bitcoin chip tape out on 16nm
Feb-17	Unveiled SSD ASIC business from front-end design through turnkey on 28nm
Jun-17	Taped out a 2nd generation HBM PHY and controller with interposer design and CoWoS package
Jul-17	Opened new Korea office
102-107	Completed 1st customer ASIC tape out on 12nm
Nov-17	Opened Nanjing (China) office
Dec-17	Completed 1st ASIC tape out on TSMC's 7nm
Dec-18	Completed 1st tape out on 16nm for HBM2 PHY+controller and TSMC's CoWoS
Mar-19	Completed 1st 5G chip tape out and entered mass production
Dec-19	Developed 5nm process design flow and taped out the 1st chip in 1Q19
Dec-19	Developed the 6nm design flow with 1st tape out targeted in 2020

Source: Company data, Credit Suisse estimates

Therefore, in the early 2000s, different from UMC's strategy to set up IC design subsidiaries leveraging UMC's manufacturing technology, TSMC kept its pure foundry business model to avoid competition with its customers, while investing in GUC and becoming the largest shareholder of GUC in 2003. TSMC provides capacity and IP library support for its customers across 8" and 12" nodes—this gives the company opportunity to access advanced nodes for global customers, in addition to consumer electronics for Taiwan customers on the mature nodes, with its leading-edge 5nm design flow ready in 2019 and 6nm production plan available in 2020. TSMC made its IPO on the Taiwan main board in 2006.

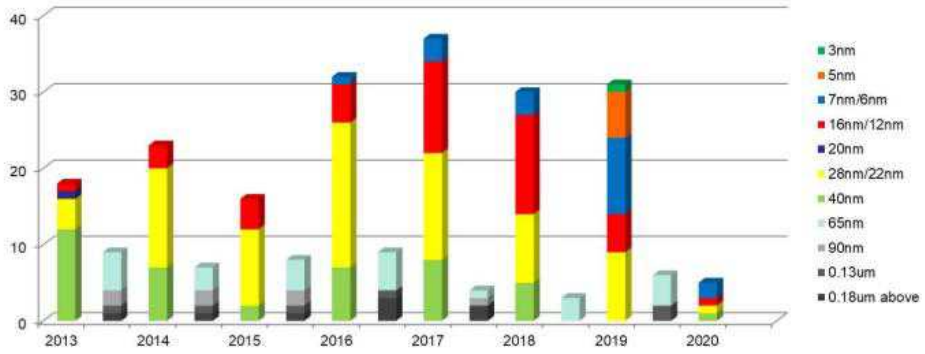
GUC is headquartered in Hsinchu, Taiwan, and has offices in the US, South Korea, Japan, and Europe and has also set up IC design and R&D supporting teams in China to serve the local customers. The company has 540 employees, with the majority of them focusing on the back-end design services—from physical design to layout—to optimise die size and chip efficiency. Although the company built a team on the front-end design service since 2018, the revenue contribution from it is still limited relative to the company's core back-end design business, as most of the front-end projects are resource-intensive and complicated.

According to the company, it has completed 230+ new tape-outs over 2013-19, with 60+ projects from 16nm and below. Out of the 60+ projects under 16nm, 10+ of them are ongoing projects. For the projects on most advanced node, the applications include the compute engine on 5nm, HPC chip and AI inference on 7nm, CPU, drone, multimedia, AI training/inference, storage and 5G on 16/12nm.

Business model

GUC signs contracts with its customers in the beginning of the NRE stage to define the scope of the design, IP usage (third-party or GUC) and turnkey services. The company charges its customers based on the milestone it achieved and also the IP licensing fee. In a NRE project, it in general has 4 milestones for an advanced project, with the first 3 related to chip design on which the company can charge the NRE revenue.

Figure 145: Global Unichip's new tape outs mostly on 28nm and below



Source: Global Unichip

The final milestone in NRE is tape-out—in this stage, GUC will buy one mask from TSMC and send the test chip to its customers to make sure the spec, performance and power consumption meet their requirements and decide whether or not to enter the mass-production stage. If the customers use GIC's turnkey service to secure capacity at TSMC, GUC would then recognise production revenue and COGs from the mask procured for manufacturing.

On the other hand, GUC's customers may also consider directly seeking TSMC's capacity support after the NRE stage as they can avoid the additional charge by GUC. However, we note TSMC usually requires full pre-payment for the capacity requested by the new customers, and securing foundry capacity in the advanced nodes could be especially challenging, as TSMC prioritises the capacity for its major customers and long-term partners (e.g., GUC) during supply tightness.

With the unpredictability of the timing for NRE milestone and mass production requested by its customers, GUC's revenue could fluctuate on a quarterly basis.

Service offering extending to back-end/memory in addition to foundry manufacturing

GUC has 140 engineers focus on developing its own IP which allows it to have a more comprehensive portfolio and technology capability for its targeted customers and applications in addition to the existing standardised IP library. In the past few years, the company has been focusing on IP, including HBM 2.0 (high-bandwidth memory interface stacked with DRAM for server, HPC, and networking products), which is important for the applications, including data storage, network communication, and PC interconnect, and has already been in production on 16nm and has made available 12nm and 7nm. The company is also developing PCIe-4 for AI and sub-6G high-speed ADC IP for 5G wireless networking applications.

Figure 146: GUC gets direct support from TSMC

Source: GUC

Figure 147: GUC's own IP solutions in the leading-edge nodes

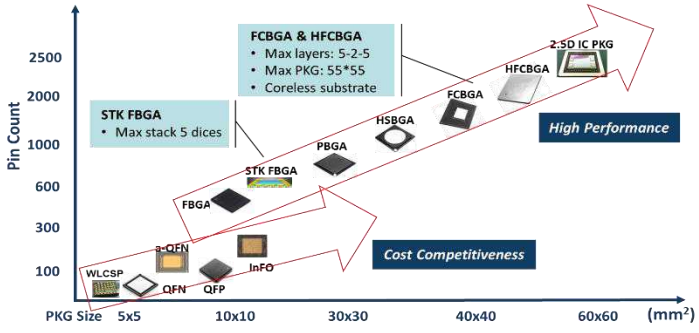
IP	2.5D	28HPC+	16FFC	12FFC	7FF	5FF
HBM2(E) PHY + Ctrl	✓	–	●	●	●	●
D2D-1.0 / 8Gbps (GUC multi-die interLink)	✓	–	–	–	●	–
D2D-2.0/ 16Gbps (GUC multi-die interLink)	✓	–	–	–	2021/Q1	2020/Q4
56G PAM PHY	–	–	–	–	●	–
32G SerDes PHY	–	–	–	–	●	2021/Q1
28G SerDes PHY	–	●	★	●	–	–
16G SerDes PHY	–	●	★	●	●	–
TCAM	–	–	●	●	●	2020/Q4
GDDR6 PHY + Ctrl	–	–	–	2020/Q4	–	–

Note1: ● means solution ready
Note2: DATE means DK (Design Kits) Ready date
Note3: ★ means porting between 12FFC and 16FFC, upon request
Note4: ✓ means 2.5D Solution Readiness of HBM and D2D

Source: GUC

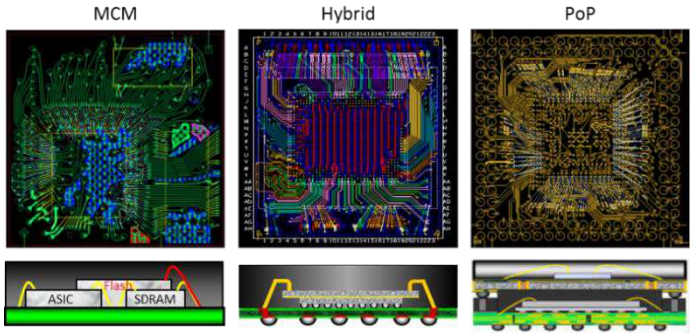
In addition to the customised IP, design, and access to advanced foundry process, GUC in the past few years has also seen the growing demand for back-end packaging provided by TSMC, which supports better performance for high-end HPC applications. The company's total system solution of chiplet interconnected by its die-to-die IP on TSMC's InFO and CoWoS interposer will be silicon-proven in 4Q20, suitable for AI customers who need to have high bandwidth memory. The company also has SiP capability and experience for chipset miniaturisation, better noise/power consumption and integration of heterogeneous and mixed process technologies. The company has successfully demonstrated its back-end technology for applications including camera, network chipset, TV SOC, codec, and MCU.

Figure 148: GUC's back-end technology strategy



Source: GUC

Figure 149: GUC believes back-end integration will be important for high-performance ASIC



Source: GUC

Competition growing in the targeted AI/networking applications

As highlighted in this report's industry section, GUC's major competition in pure IC design service is from Faraday and Alchip. Compared with Faraday, GUC has an advantage on the technology support from TSMC from mature to advanced nodes. Although Faraday started working with Samsung's SAFE programme in 2018 for advanced projects, the progress has been slow. For the competition from Alchip, GUC believes the advantage it has is its larger revenue scale, major TSMC support, and customised chipset design with its own IP.

GUC's major competition from IC design houses are Broadcom and Mediatek. However, with ASIC design being only part of their business, we believe they are selective and only consider projects delivering higher ROI and margins, with Broadcom's GMs/OpMs at 45%/15% and Mediatek's at 40%/10%. In addition, we believe the pure IC design service companies like GUC still have advantage over their fabless peers as they don't design chipsets competing with their customers.

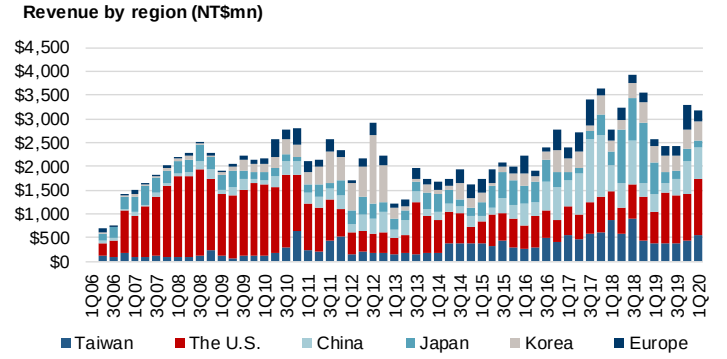
For Broadcom, the company has a strong SerDes IP portfolio for high-end networking and DPU (dataflow processing unit) and saw a strong enterprise networking ASIC business demand offset its slower set-top box and optical businesses in the past year. For Mediatek, the company has been successful in game console peripheral ASIC and has been working on Ethernet switch ASIC for its customers, targeting to ramp from 2H20. In addition to the higher return requirement leading to higher cost for their customers for customised design service, the fabless companies have interest conflict with their customers (vs pure IC design service companies with 100% design for their customers).

A more diversified mix balancing the US and China

GUC's revenue by region has been shifting in the past few years, with the US contributing the most at 38% of sales in 2019 on more AI and networking projects. On the other hand, the revenues from Japan (cryptocurrency) and Korea (Samsung's 4G modem) have been dropping in the past few years

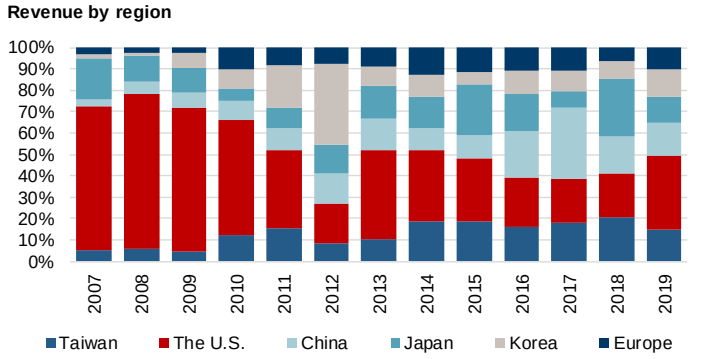
Amid the growing China semiconductor ecosystem, GUC also set up a team in Nanjing, with headcount increasing to 200 in the past few years, and the majority of them are engineers to support local customers. The company's revenue from China reached 23% in 2017 on the surge in the Bitcoin chipset demand, though the sales dragged for the business in 2018 and is now limited following the drop in cryptocurrency pricing. Starting in 2019, due to rising geopolitical tensions, the company has been trying to avoid sensitive projects—thus, it has no exposure to Huawei or government-related projects. In the meantime, GUC has been focusing more on the AI and cloud training business for internet companies in China.

Figure 150: GUC's China business slowed down following cryptocurrency correction



Source: Company data, Credit Suisse estimates

Figure 151: GUC's revenue mix is still more diversified across different regions vs. Alchip's China and U.S. focus

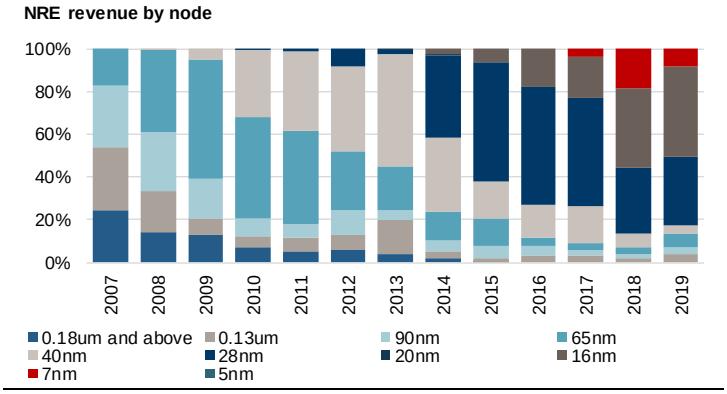


Source: Company data, Credit Suisse estimates

AI and 5G ramp partially offset by slow consumer

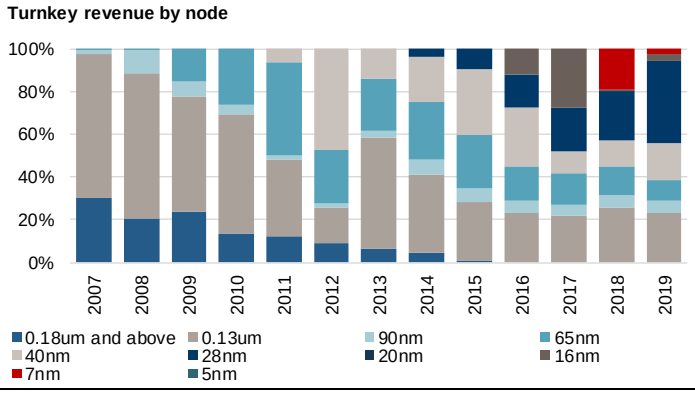
GUC is selective on its customers to ensure most of the NRE projects can be successfully transitioned to mass production due to the design capacity constraint. The resource allocation is also varied by application, with AI projects the most time-consuming (6-8+ quarters) to finish the design, much longer compared with 1-2 months for consumer applications and less than 1 month for cryptocurrency. In the past few years, the conversion rate from NRE to the mass production business has been 30-40%.

Figure 152: GUC's NRE revenue are mostly 28nm and below



Source: Company data, Credit Suisse estimates

Figure 153: The turnkey business is mostly from 28nm and above nodes, suggesting slow ramp for advanced projects



Source: Company data, Credit Suisse estimates

GUC's top NRE projects include 3 projects for AI, 4 for networking for 5G base station and network processor, 1 for emulator for an EDA tool provider, and 1 SSD controller IC. On the major turnkey projects, the Top 2 projects are for memory makers SSD products, followed by a wide range of applications including server, drone, and solar panel and game console flash controller. We discuss GUC's projects in AI and networking in detail below.

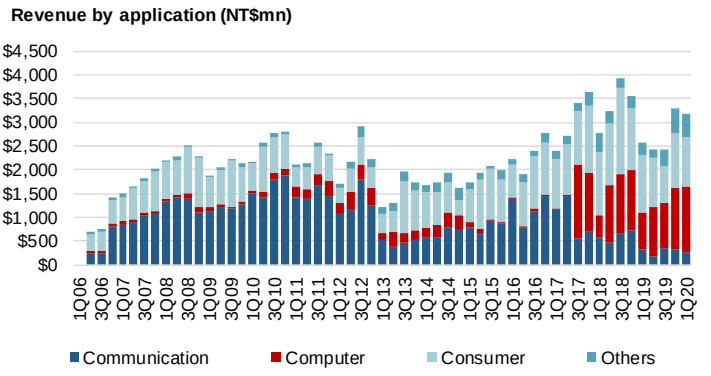
Figure 154: GUC's key projects and customers in 2020

GUC's sales by application	2019	Key projects in 2020	Major customers
Computer	38%	Cloud AI training and inference, HPC, BMC, SSD controller	U.S. and China internet companies and memory maekrs
Communication	11%	Wireless (5G), Wired (ethernet switch)	China 5G infrastructure supplier
Consumer	39%	TV SoC, surveillance camera, drone, game console	Japan and China customers
Others	12%	Solar	NM

Source: Credit Suisse estimates

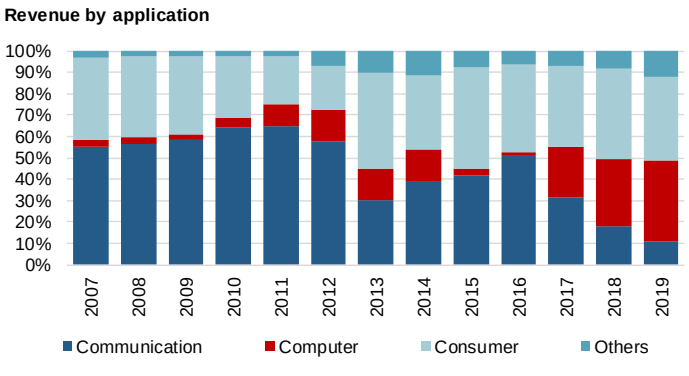
We discuss the company's key contribution and opportunity by applications as below.

Figure 155: GUC's growth in computing partially offset by slower communication and declining consumer



Source: Company data, Credit Suisse estimates

Figure 156: Computing and consumer business contributes 75-80% of GUC's sales



Source: Company data, Credit Suisse estimates

Computing (44% of sales in 2019): GUC's computing business started to ramp from 2H17 when cryptocurrency chipset demand surged along with the bitcoin pricing. At peak level, the cryptocurrency-related projects contributed 28% of its sales in 2017, lifting its sales up 31%/11% YoY in 2017/18. However, with the drop in cryptocurrency pricing in 2H18, the demand decline also dragged it sales down 20% in 2019 (sales would be +2% YoY ex-crypto).

Despite the sluggish demand for cryptocurrency, the company was able to keep its computing business healthy in 2019 supported by the new applications including AI, HPC, supercomputer,

BMC and new chipset for servers and PC SSD controller. For the memory controller business, we expect the company to continue to secure the new-generation SSD controller business from the memory makers in Korea and the US, supporting the healthy turnkey revenue when the chipsets enter into production. The company is also developing a BMC chipset for its US server customer which should see good growth with growing data centre demand.

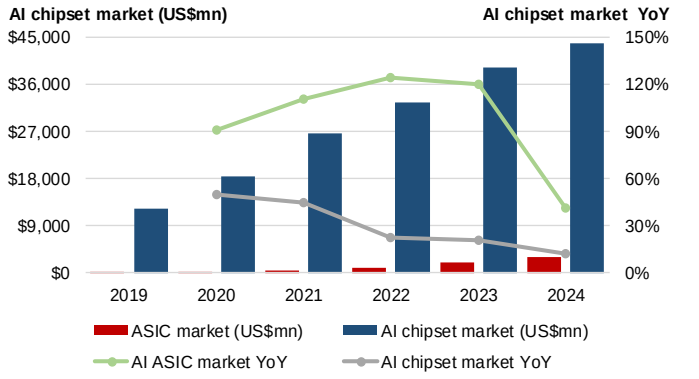
Figure 157: Different types of chipset comparison for AI computing

	CPU	GPU	FPGA	ASIC
Processing peak power	Moderate	High	Very high	Highest
Power consumption	High	Very high	Very low	Low
Flexibility	Highest	Medium	Very high	Lowest
Training	Low	Moderate	Low-moderate	High
Inference	Low	Moderate	High	High
Cost per compute	High	High	Moderate	Low
Major applications	General computing	Cloud training Cloud inference	Cloud inference Edge inference	Cloud training Cloud inference Edge inference
Companies	Intel, AMD	Nvidia, AMD	Xilinx, Altera	Diversified

Source: Credit Suisse estimates

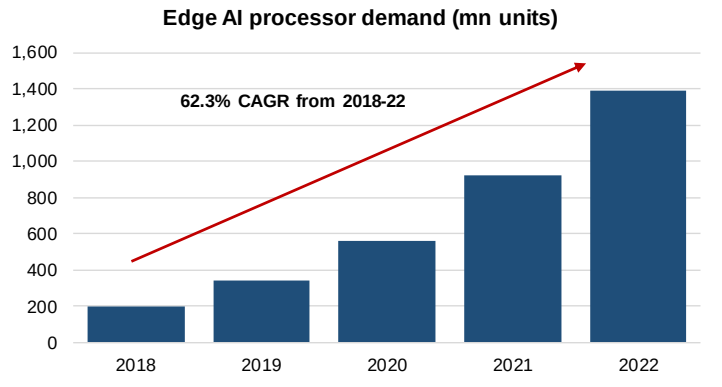
For the company's computing business, we see the key growth driver for the company is on the AI computing proliferation. In our industry section, we highlighted that the semiconductor industry is also evolving beyond the traditional CPU powered computing ecosystem along with the development and investment in AI. Gartner expects global AI semiconductor revenue to grow from US$12.3 bn in 2019 to US$43.9 bn in 2024 at a CAGR of 29%, with key drivers from the main processor, digital signal processor (DSP), GPU and FPGA. Based on IDC's estimate, the global AI edge processing unit will grow from 200 mn units in 2018 to 1.4 bn units in 2022 at a CAGR of 62%.

Figure 158: AI ASIC is going to outgrow the AI semiconductor market



Source: Gartner, Credit Suisse estimates

Figure 159: Edge AI processor is projected to reach 1.4 bn units in 2022



Source: IDC, Credit Suisse estimates

GUC has been working on the AI projects more aggressively since 2017 and has multiple AI projects on 16nm/12nm for cloud training and inference, with 2 tape-outs in 2018 and 1 in 2019. The company continues to working with industry leaders, including 2 projects on 7nm for AI cloud computing. We expect the company to add more projects for AI ASIC for ASIC (e.g. Alibaba's fabless subsidiary called T-Head) and some of the projects will finish the NRE stage and should start mass production in 2H20-21. AI projects entering mass production stage in 2020 include an AI training chip on 16nm with GUC's HBM2 IP for its data centre customer and HPC ASIC adopting TSMC's turnkey service (advanced manufacturing + 2.5D packaging) for its hyperscale customer. The revenue contribution from AI applications should start seeing meaningful growth from a low base in 2019 (0.4% of sales) to 5-10% in 2020 and should further grow to 20% of sales in 2021, keeping its computing business the main driver for its growth in the next few years.

Figure 160: Alibaba's IC design subsidiary T-Head launched its AI inference chipset Hanguang 800 on TSMC's 12nm

Source: T-Head

Consumer (33% of sales in 2019): GUC's main exposure in consumer applications include drone, flash controller for game console and digital camera. We believe the company should see continued traction for its chipset design service for high-end consumer applications including drone (Ambarella for DJI), surveillance camera (Sony), and game console (Nintendo Switch). However, the consumer business may be softer in 2020 due to COVID-19.

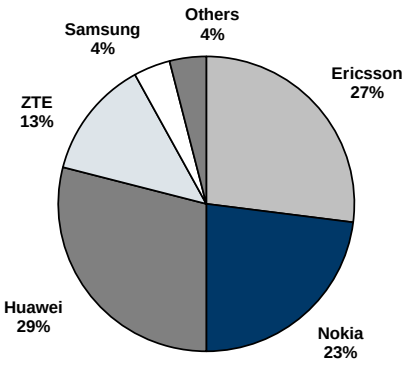
Communication (8% of sales in 2019): GUC's communication is mostly focused on the base station/mobile infrastructure and enterprise networking business. The company has phased out the mobile business as the industry is more consolidated, with the major fabless and system houses having the ability to design customised chipsets for mobile device differentiation.

Specifically for the opportunity in networking, GUC has been working on both wired and wireless chipsets for its customers. For the wired business, the company mainly designs networking processors and switches for its customers. However, we believe the business is seeing growing competition from the more aggressive push by the established players Broadcom and Mediatek.

In the wireless segment, GUC is focusing on the 5G projects with its customers in China, Korea and Europe for 5G telco equipment (e.g., small cell), with 1 project developed in 2018 entering production in 2H19 which we believe is for ZTE's 5G multiband chip on 7nm. The company also has another 5G base station project with ZTE on 5nm under development.

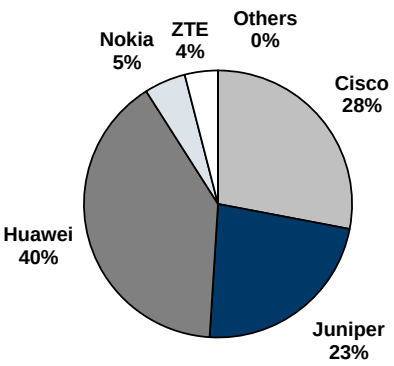
According to Gartner, ZTE has some share in wireless and network infrastructure with 13% in wireless radio access and 4% in core routing, lagging Huawei (40%), Ericsson (27%), Nokia (23%).

Figure 161: Huawei at 29% wireless radio share in 2018



Source: IDC, Credit Suisse European Telecom Equipment (Achal Sultania)

Figure 162: Huawei had 40% core routing share in 2018

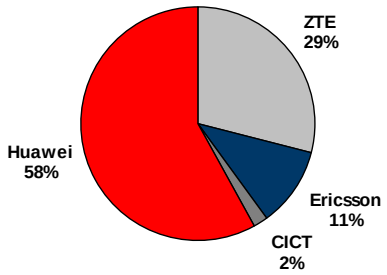


Source: IDC, Credit Suisse European Telecom Equipment (Achal Sultania)

Although the scale may not be as meaningful as Huawei, ZTE is still a critical portion of China's infrastructure build-out, having secured 29% market share in the second phase of China Mobile's 5G base station tender. With the US restriction on Huawei's access to semiconductor

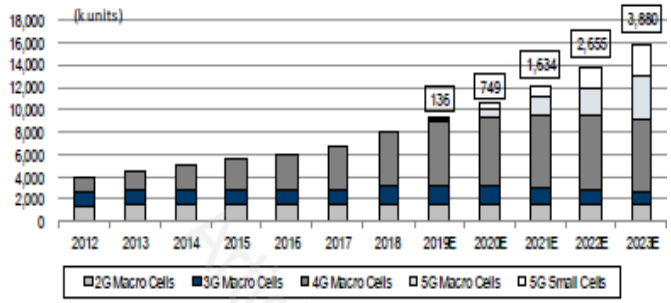
components, we expect ZTE to benefit from it and will be an important piece to reach its estimates for 613k base station adds in 2020 and 885k in 2021.

Figure 163: Huawei won 58% of China Mobile's tender



Source: IDC, Credit Suisse European Telecom Equipment (Achal Sultania)

Figure 164: Hi Silicon has 9% share in mobile phone chips



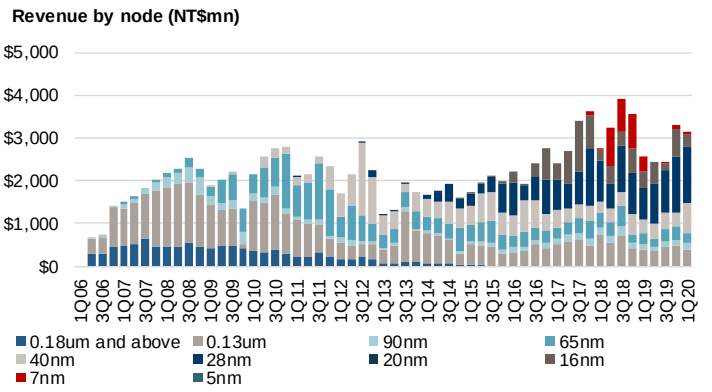
Source: Company Data, Credit Suisse Estimates

With growing 5G penetration in China, Korea and Europe in the next few years, GUC targets its wireless business to grow from 3%/10% of its sales in 2018/19 to 15% of its sales by 2024.

Growth in the advanced nodes partially offset by still high contribution in the mature applications

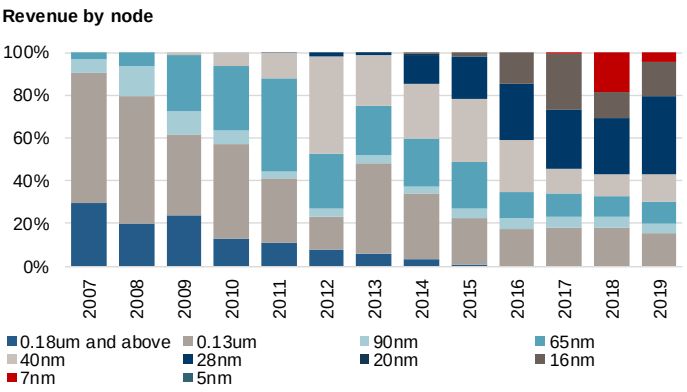
GUC's revenue by node shifted along with TSMC's technology migration and its targeted applications. Unlike Alchip focusing only on the most leading-edge applications, GUC still serves a wider range of customers, including consumer, game console, and SSD controller to AI, data centre and networking, making the revenue distribution long-tailed from legacy 0.13um to advanced 7nm. The company's revenue contribution gradually shifted from 65nm and 40nm in 2011-15 to 28nm in 2016-19. For 16nm and 7nm, the nodes saw a meaningful pick-up in 2017-18, +140%/+27% YoY to 27%/39% of the company's total sales, mainly driven by the surge in the Bitcoin ASIC demand (24% of its sales in 2018) for mining activity. However, the demand drop following cryptocurrency pricing collapse also led to a 47% YoY sales decline for 16nm and 7nm in 2019, dragging the company's sales down 20% YoY in 2019 (ex-cryptocurrency +2% YoY).

Figure 165: GUC's sales growth has been driven by 28nm and below nodes



Source: Company data, Credit Suisse estimates

Figure 166: The mature nodes which is seeing limited growth potential still contributes 40% of GUC's sales



Source: Company data, Credit Suisse estimates

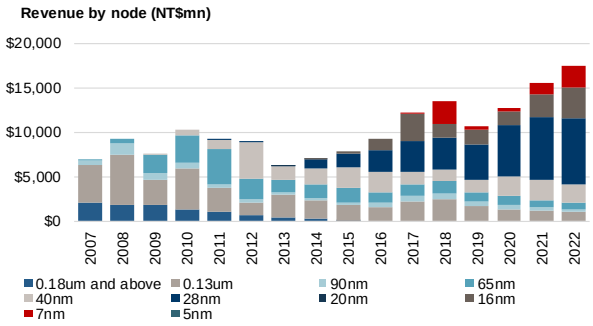
With more projects for AI and 5G networking chipsets entering into production, we estimate the revenue contribution from 7nm will start to grow more meaningfully in 2020 from a low base in 2019. The company should also see growing contribution on 16nm from longer life cycle networking projects into production and EDA emulator project, offsetting softer 28nm dragged by slower consumer demand. For the most advanced 5nm, GUC has the capability to work on the chipset designs on the node for its customers and recognised the test wafer revenue in

2019. However, it may take a few years for the node to ramp more meaningfully for GUC due to longer design cycle and higher investment required for its customers.

Business should recover in 2H20

The company's 1Q20 sales were down 4% QoQ, though still up 24% YoY, with production pull-in from 5G networking projects offset by decline in NRE following a high 4Q20 base for some projects. GUC's 2Q20 sales were down 8% QoQ, at the high-end of the company's guidance of a high-single-digit-to-low-teen decline QoQ in 2Q20, with soft NRE partially offset by stronger turnkey and IP business. The company already reported 2Q20 EPS at NT$0.27, below street's expectation of NT$1.01. We believe the lower-than-expected earnings in 2Q20 is mainly due to the milder-than-expected GM improvement with mix shifting away from the higher-margin NRE business, while OpM also saw a reverse leverage due to the lower revenue scale.

Figure 167: GUC should see faster growth on 16nm and initial ramp on 7nm

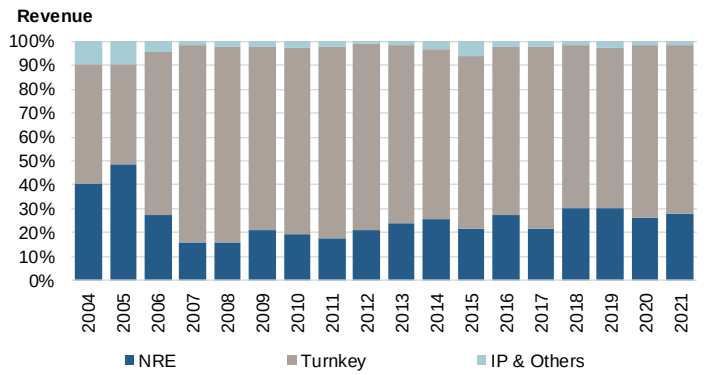


Source: Company data, Credit Suisse estimates

Although the sales have declined QoQ through 1H20, we expect the company's turnkey business to recover in 2H20 and model 37% YoY growth in 2020E, supported by production ramp for its AI and networking projects entering into production, while its existing business will continue to be its cash cow. The NRE business should also recover modestly from a low base as the company works on new AI and 5G projects, putting its full-year sales on track to decline 8% YoY. Factoring the growth in turnkey partially offset by slower NRE, we expect the company's sales to grow 21% YoY in 2020.

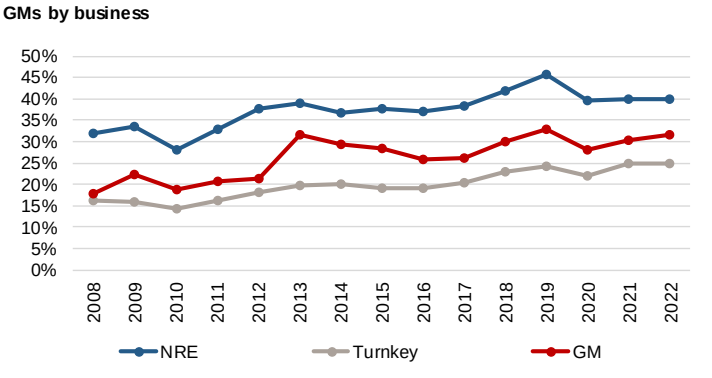
Margins down in 2020 on the rising consumer/turnkey

Figure 168: GUC's NRE contribution at 20-30% is much lower vs Alchip's 40-50%



Source: Company data, Credit Suisse estimates

Figure 169: GUC's GMs by business



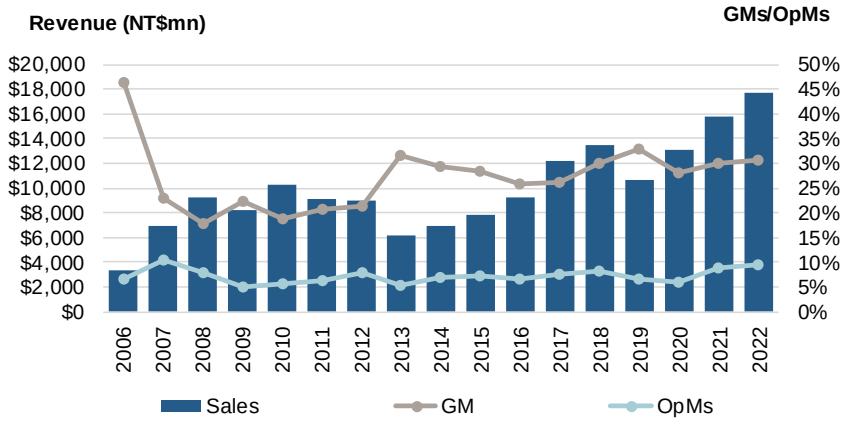
Source: Company data, Credit Suisse estimates

GUC's GMs is highly correlated with its mix of NRE vs turnkey. In NRE stage, most of the cost are related to chip design cost in R&D expense (opex) and limited COGs occurred before entering into mass production.

For turnkey service, due to the high cost for mask layers it needs to procure for its customers (US$1.5 mn for 28nm, US$3 mn for 16nm and US$6 mn for 7nm), the high pass-through cost would impact GUC's margins profile, especially in the initial stage when the mask starts to depreciate.

Based on our estimate, GUC's GMs for its NRE business in general at 30-50% range, higher compared with turnkey service at 15-30%. In the past two years, the company's NRE contribution rose to 30% in 2018-19, driven by the long design cycle for growing AI and machine learning projects. The NRE mix is higher at 30% in the past 2 years compared with its long-term 20-25% and lifting its GM from mid-20% levels to 30%/33% in 2018/19.

Figure 170: GUC should see better growth from AI and 5G though profitability will only be stable due to lower NRE and high % turnkey is for mature node at low margins



Source: Company data, Credit Suisse estimates

In 1Q20, the company's GMs in 1Q20 has dropped from 32.8% in 4Q19 to 24.1% in 1Q20 due to lower NRE contribution following the pull in 4Q19 (down from 29% in 4Q19 to 25% in 1Q20) and also higher mask cost. We expect the margins should improve from 1Q20 levels following the initial spending on the mask while there will be more NRE projects on the advanced nodes to lift the contribution once they achieve the milestones. However, with some AI and 5G networking projects moving from NRE to mass production with higher mask depreciation in the advanced nodes in 2020, we expect the company's GMs to decline from 33% in 2019 to 27.9% in 2020.

GUC's fab lite model supports a solid balance sheet

As a semiconductor IC design service provider, GUC only helps to design the chipsets for their customers and sourcing the manufacturing to its foundry and back-end partners, rather than producing chipsets. Although its inventory levels can be volatile from 30 to 107 days depending on the shipment schedule, its customers are required to take all of the chipsets after the production, limiting the inventory risk. The company's customer base is diversified from start-ups to established system houses, but the payable risk is limited as the company is able to keep receivable days between 25-55 days.

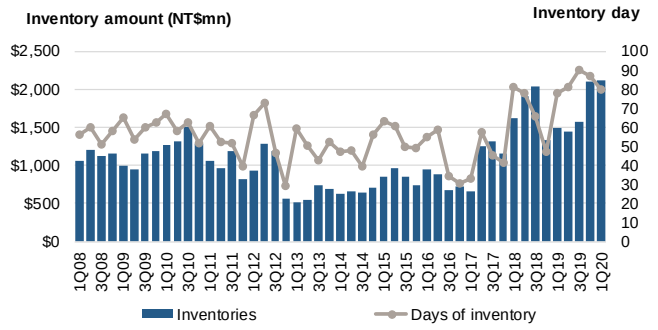
Figure 171: GUC's balance sheet is healthy

Balance Sheet (NT$ mn)	1Q20A	4Q19	Diff %
Cash and Investments	3,189	2,954	8%
Total Debt	0	0	
Net Cash	3,189	2,954	8%
Net Cash/Share	**20.72**	**18.97**	**1.75**
Accts. Receivable	1,364	1,418	-4%
Receivable Days	**39**	**39**	**0**
Inventory	2,108	2,103	0%
Inventory Days	**80**	**87**	**-7**
Accounts Payable Days	70	63	7
Cash Conversion Cycle	**49**	**63**	**-13**
SH Equity	4,412	4,313	2%
Book Value / Share	**32.92**	**32.18**	**0.74**

Source: Company data, Credit Suisse estimates

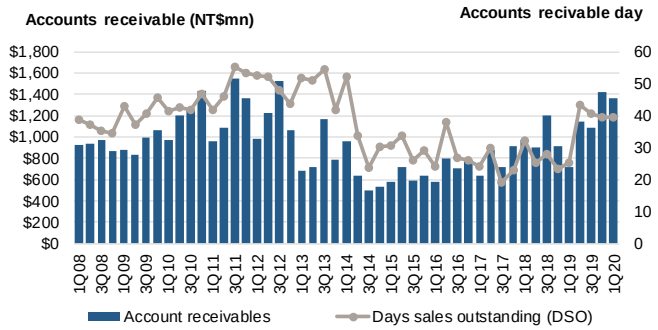
On the cash position, GUC has NT$2.7 bn net cash (NT$20.72 net cash per share) with limited debt. We expect the company to generate solid cash flow from healthy sales growth more than offsetting volatility in GM and sufficient for it business operation.

Figure 172: GUC's inventory levels is higher due to softer consumer demand but should return to normal



Source: Company data, Credit Suisse estimates

Figure 173: GUC's AR days is still within long term range



Source: Company data, Credit Suisse estimates

Healthy cash flow supports a steady growth dividend

Although GUC's business is a capital light semiconductor IC design service model, the company still needs to procure photomasks and EDA tool upgrades which are more expensive in the advanced nodes, lifting capex intensity from 1-2% from 2007-17 to 4-5% in 2018-19.

Figure 174: GUC's asset light business model should improve its FCF

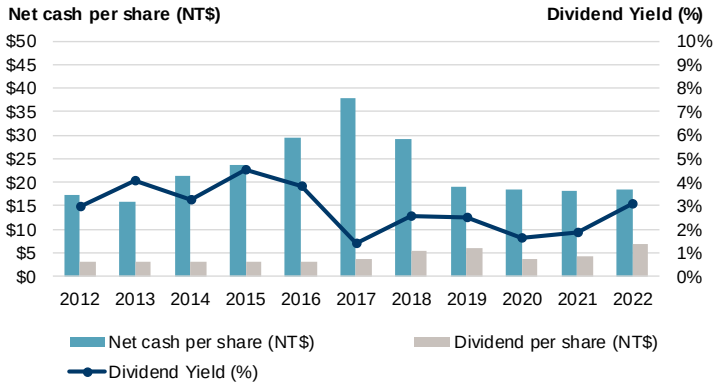
Annual (NT$mn)	CY10	CY11	CY12	CY13	CY14	CY15	CY16	CY17	CY18	CY19	CY20	CY21	CY22	CY03-17 Avg
Revenue	10,271	9,147	9,014	6,177	6,952	7,762	9,290	12,161	13,460	10,710	13,039	15,775	17,716	8,223
Capital spending	-70	-44	-82	-47	-80	-78	-69	-143	-529	-490	-1,000	-1,000	-1,000	-81
Capex/Revenue (%)	**0.7**	**0.5**	**0.9**	**0.8**	**1.2**	**1.0**	**0.7**	**1.2**	**3.9**	**4.6**	**7.7**	**6.3**	**5.6**	**1.0**
Dep and amort	287	244	234	225	225	225	237	256	413	598	595	597	597	235
Depr/Revenue (%)	**2.79**	**2.67**	**2.59**	**3.64**	**3.24**	**2.89**	**2.55**	**2.11**	**3.07**	**5.58**	**4.57**	**3.78**	**3.37**	**2.86**
Operating cash flow	487	1,363	1,286	300	1,328	934	1,408	1,928	227	108	1,700	1,894	2,123	924
Free cash flow	**417**	**1,319**	**1,204**	**253**	**1,248**	**856**	**1,339**	**1,784**	**-302**	**-382**	**700**	**894**	**1,123**	**843**

FCF and Dividend Yields	CY10	CY11	CY12	CY13	CY14	CY15	CY16	CY17	CY18	CY19	CY20	CY21	CY22	CY03-17 Avg
FCF / Share (NT$)	3.15	9.85	8.99	1.89	9.30	6.39	9.99	13.32	-2.25	-2.85	5.23	6.67	8.38	6.97
FCF Yield (%)	2.6	9.9	8.9	2.5	10.0	9.7	12.7	5.2	-1.1	-1.2	1.7	2.2	2.7	6.1
FCF / EV (%)	**1.6**	**5.0**	**4.5**	**1.0**	**4.7**	**3.2**	**5.0**	**6.7**	**-1.1**	**-1.4**	**2.6**	**3.4**	**4.2**	**3.2**
Dividend per share (NT$)	2.00	2.99	3.00	3.00	3.00	3.00	3.00	3.50	5.26	6.08	3.55	4.50	7.35	2.75
Pre-Dividend closing price (NT$)	122.00	99.50	100.50	74.00	92.70	66.00	78.50	255.00	206.00	241.00	306.50	306.50	306.50	128.68
Dividend Yield (%)	**1.6**	**3.0**	**3.0**	**4.1**	**3.2**	**4.5**	**3.8**	**1.4**	**2.6**	**2.5**	**1.2**	**1.5**	**2.4**	**2.6**

Source: Company data, Credit Suisse estimates

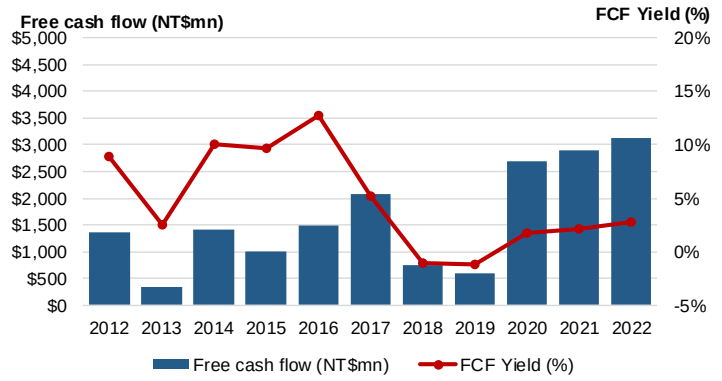
We estimate the company's capex to stay at similar level in 2020-21, supporting free cash generation and sufficient to support a 60-70% dividend payout policy.

Figure 175: GUC's improving cash position should support a better dividend policy



Source: Company data, Credit Suisse estimates

Figure 176: GUC's FCF yield should improve to 5% in 2020-22E



Source: Company data, Credit Suisse estimates

Target price reflects 29x the 2021E opportunity

We believe GUC will benefit from growing ASIC demand from system house for AI and 5G applications for better customisation on the performance and power consumption. The company should also leverage its close relationship with TSMC on the foundry production and extending into back-end service in the past 18 years to secure sufficient foundry support in the advanced nodes along with its IP portfolio.

Figure 177: GUC's 2Q20-3Q20 and 2020-21 estimates—CS vs street

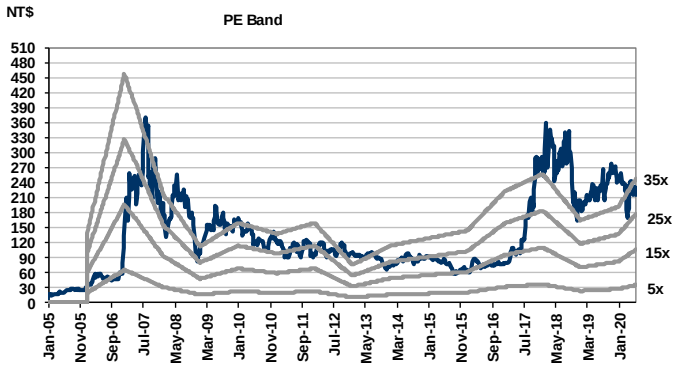
	2Q20		3Q20		4Q20		2020		2021	
(NT$ mn)	CS	Street	CS	Street	CS	Street	CS	Street	CS	Street
Sales	**$2,927**	**$2,959**	**$3,301**	**$3,276**	**$3,641**	**$3,605**	**$13,039**	**$12,994**	**$15,775**	**$15,500**
Chg	*-7.7%*	*-6.7%*	*12.8%*	*11.9%*	*10.3%*	*10.1%*	*21.7%*	*21.0%*	*21.0%*	*19.3%*
GM (%)	**25.2%**	***29.6%***	**28.0%**	***31.3%***	**29.4%**	**32.1%**	**26.8%**	**29.8%**	**30.0%**	**30.7%**
OpM (%)	**1.9%**	**5.4%**	**4.8%**	**8.4%**	**6.8%**	**9.4%**	**4.1%**	**6.7%**	**8.3%**	**8.0%**
EPS (NT$)	**$0.27**	**$1.01**	**$1.16**	**$1.75**	**$1.83**	**$2.25**	**$4.00**	**$5.93**	**$8.60**	**$8.99**

Source: Company data, Credit Suisse estimates

On growing HPC and networking market opportunity, we expect GUC to grow 15-20% in 2020-21. However, we believe the company's earnings power will be dragged by lower margins with mix shifting to the turnkey business, offsetting its growing revenue scale and putting EPS at NT$4.00/NT$8.60 in 2020E/2021E.

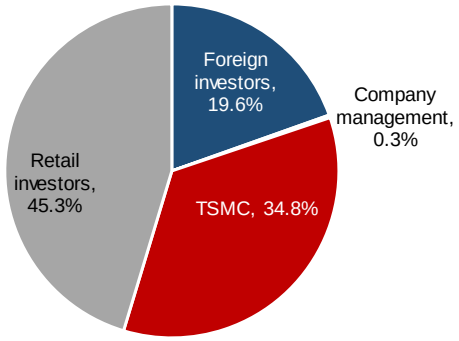
GUC is currently trading at 51x/31x 2020/2021E CS estimates, at the upper half of its long-term range of 15x-35x P/E. Although the growth outlook is promising for 5G networking and AI projects with the internet companies in China and the US, the contribution is still mild now and we would monitor the company's progress on delivering its target. Beyond the high growth potential in its computing business, the company still has 30% revenue from the consumer business which has not been growing in the past few years and will see slower demand in 2H20 due to COVID-19. The company's earnings opportunity will also be dragged by mix shifting to lower-margin turnkey business at higher depreciation for the mast investment on the advanced nodes.

Figure 178: GUC's share at the upper half of its 15x-35x range



Source: Company data, Credit Suisse estimates

Figure 179: GUC's ownership



Source: Company data, Credit Suisse estimates

We set our target price at NT$250 based on 29x 2021E P/E of NT$8.60, close to the current share price of NT$306.5. We believe the company's share is fairly valued at the upper half of its historical range factoring in its opportunity in 5G and AI, though the timing of the project ramp for meaningful revenue contribution and profitability remain uncertainty.

GUC trades at a premium to its peers on better business outlook

GUC is currently trading at 51x/31x 2020E/2021E P/E, above its peers' average of 39x/27x, on the back of its healthy growth outlook in the next few years with modest OpM expansion.

Figure 180: Taiwan IC design service valuation vs their global fabless peers

Company	Ticker	Local Price 7/17/2020	Mkt Cap (US$mn)	Ent. Value (US$mn)	Range	P/E Multiple 2020	P/E Multiple 2021	EV/EBITDA 2020	EV/EBITDA 2021	EV/Sales 2020	EV/Sales 2021	P/B Multiple 2020	P/B Multiple 2021	ROE 2020	ROE 2021
IC design service															
Global Unichip	3443.TW	$284.00	$1,291	$1,173	156.0-323.5	70.9	33.0	32.1	19.0	2.8	2.3	8.7	7.4	12.3	22.5
Alchip	3661.TW	$480.00	$999	$888	93.0-575.0	31.0	22.9	11.5	9.4	4.0	3.0	7.2	6.0	23.3	26.1
Faraday	3035.TW	$48.95	$412	$412	29.2-63.5	29.7	23.6	NM	NM	NM	NM	2.3	2.2	7.7	9.3
IC design service Median:						**31.0**	**23.6**	**21.8**	**14.2**	**3.4**	**2.7**	**7.2**	**6.0**	**12.3**	**22.5**
IC design service Mean:						**43.9**	**26.5**	**21.8**	**14.2**	**3.4**	**2.7**	**6.1**	**5.2**	**14.4**	**19.3**
Taiwan Fabless															
Mediatek	2454.TW	$607.00	$32,717	$26,969	274.0-661.0	30.0	20.4	18.3	12.1	2.7	2.1	3.1	2.8	10.3	14.0
Novatek	3034.TW	$262.00	$5,408	$4,649	152.0-285.5	17.3	16.2	12.2	11.1	2.0	1.9	4.4	4.2	25.7	25.7
Realtek	2379.TW	$342.50	$5,934	$4,906	162.0-367.5	23.6	19.2	16.9	13.6	2.2	1.9	5.9	5.3	25.0	27.4
Egis	6462.TWO	$196.50	$476	$386	121.5-314.0	14.1	12.2	8.6	7.2	1.6	1.3	4.5	4.0	31.5	32.7
Elan	2458.TW	$139.50	$1,438	$1,255	70.0-144.0	17.4	16.7	11.4	11.8	3.2	3.2	5.2	5.0	30.0	30.3
Global Unichip	3443.TW	$284.00	$1,291	$1,173	156.0-323.5	70.9	33.0	32.1	19.0	2.8	2.3	8.7	7.4	12.3	22.5
Himax	HIMX	$3.81	$656	$765	1.8-5.1	47.6	19.5	20.1	11.6	1.0	0.8	1.5	1.4	3.1	7.1
Parade	4966.TWO	$1,075.00	$2,918	$2,554	513.0-1135.0	29.3	24.0	22.6	18.3	5.8	5.0	6.6	5.7	22.6	23.6
Silergy	6415.TW	$1,735.00	$5,426	$5,426	594.0-2015.0	49.2	38.3	45.6	35.1	11.9	9.6	9.1	7.7	19.6	21.9
Taiwan Fabless Median:						**29.3**	**19.5**	**18.3**	**12.1**	**2.7**	**2.1**	**5.2**	**5.0**	**25.0**	**25.7**
Taiwan Fabless Mean:						**29.9**	**21.9**	**20.5**	**16.0**	**4.8**	**4.1**	**6.2**	**5.5**	**22.7**	**25.5**
China Fabless															
Goodix	603160.SS	$215.56	$14,068	$13,328	142.6-373.3	58.1	57.1	54.8	51.2	12.2	11.6	13.1	10.6	22.6	18.6
Will Semi	603501.SS	$208.16	$25,689	#VALUE!	60.3-249.7	64.9	39.5	38.0	25.5	8.9	6.4	15.2	10.5	23.4	26.7
Wingtech	600745.SS	$130.00	$20,882	$22,909	34.8-166.3	49.5	34.7	26.7	21.0	2.4	1.8	6.1	5.2	15.3	16.8
Montage	688008.SS	$96.85	$15,637	$14,585	58.3-117.6	92.8	69.3	95.3	65.8	45.2	33.7	13.5	11.7	15.2	17.6
Gigadevice	603986.SS	$243.00	$16,348	$16,080	61.6-304.4	102.1	98.4	89.6	81.7	22.5	18.4	11.0	9.9	10.4	10.1
Maxscend	300782.SZ	$465.30	$11,969	$11,829	114.5-521.9	102.0	73.0	87.0	60.6	34.6	24.8	34.9	25.0	34.8	36.2
SG Micro	300661.SZ	$335.17	$7,445	$7,323	63.0-390.8	205.4	138.5	192.9	127.4	48.0	33.4	39.4	31.7	20.7	23.7
NavInfo	002405.SZ	$18.50	$5,186	$4,981	13.3-21.4	106.9	70.3	66.5	50.3	13.8	10.9	4.5	4.2	4.7	5.8
China Fabless Median:						**97.4**	**69.8**	**76.8**	**55.9**	**18.2**	**15.0**	**13.3**	**10.6**	**18.0**	**18.1**
China Fabless Mean:						**97.7**	**72.6**	**81.3**	**60.4**	**23.5**	**17.6**	**17.2**	**13.6**	**18.4**	**19.4**

Source: Company data, The BLOOMBERG PROFESSIONAL™ service, Credit Suisse estimates

We also used CS HOLT®, a CS valuation tool that derives a stock price based on a company's cash flow return on investment (CFROI®) and asset growth. We would note the valuation tool

warrants an NT$230 share price based on our modelled sales growth, margin assumptions and investment plans through 2022. The figure above shows our key assumptions.

Figure 181: GUC's CS HOLT valuation

GLOBAL UNICHIP CORP. (3443)

Semiconductors
Market Cap: 40.1 TWD

Price: 299.00 (15 Jul, 2020)
Warranted Price: 230.01 TWD (-23%)

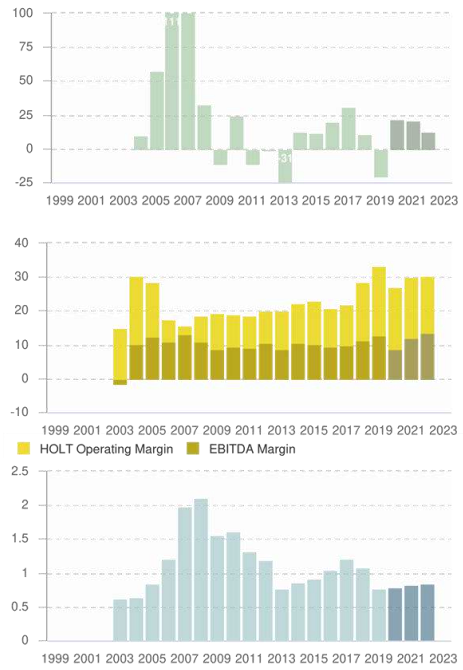
Sales, Margins & Turns Inputs

	2019	2020	2021	2022
Sales Growth %	-20.4	21.7	21.0	12.3
EBITDA %	12.7	8.7	12.1	13.5
Effective Tax Rate %	19.1	18.8	19.0	19.0
Asset Turns	0.77	0.79	0.82	0.85
CFROI %	12.0	7.2	10.6	11.6
Real Asset Growth %	12.3	18.0	15.1	7.3
Discount Rate	5.25	5.00		

Warranted Valuation

Warranted Valuation	Amount (MM)	Per Share
+ PV Cash Flow Existing Assets	10,194	76.07
+ NPV Cash Flow Future Investments	20,412	152.31
+ Market Value Investments	NA	0
Total Economic Value	30,606	228.38
- Market Value of Debt & Equivalents	531	3.97
- Market Value of Minority Interest	0	0
Partial Year Adjustment	749	5.59
Warranted Equity Value	**30,824**	**230.01**
Winddown Value/Share		**72.10**
Winddown Ratio		4.15
Shares Outstanding	134	**downside -23%**

Sales, Margins & Turns



Note: North American companies only. Metrics shown are gross investment base weighted. Warranted valuation figures in millions of TWD

Source: Company data, Credit Suisse estimates

Profile of GUC's senior management

Dr. Ken Chen—President. Dr. Ken Chen was named the President of GUC in 2016, with strong record in leadership, marketing, sales and technology in the semiconductor industry. Prior to joining GUC, Dr. Chen served as Senior Director of Business Development and was responsible for the networking and consumer electronics segments at TSMC. Dr. Chen holds the PhD in Materials Science & Engineering from Stanford University.

Daniel Chien—CEO. Mr. Daniel Chien is the CFO of GUC. Prior to joining GUC in 2006, Mr. Chien served as CFO in Ali Corp. Mr. Chien holds the Master of Science degree in MBA degree from the University of Texas at Arlington.

Dr. Louis Lin—SVP. Dr. Louis Lin is the Senior Vice President in Design Service and Core IP R&D in GUC. He joined GUC in 1998 and has over 20 years of experience in various ASIC design fields. Dr. Lin holds the PhD degree in Electronics Engineering from National Chiao Tung University.

C. Fu—SVP. C. Fu is the Senior Vice President in SoC R&D, Operations, Quality & Reliability Assurance, Marketing & Sales. Prior to joining GUC, C.Fu worked at TSMC for over 15 years. Mr. Fu holds the master degree in Electronics Engineering from National Tsing Hua University.

Key risks to our NEUTRAL rating

- **Macro uncertainty leads to slower semiconductor investment.** We believe the global macro uncertainty triggered by COVID-19 could lead to a more conservative investment

approach by the IC design service companies' customers as they could push out the semiconductor projects, which is witnessed in GUC's business slowdown in 2009, 2011-13 along with global economy correction.

- **Timing uncertainty in AI chipset development.** With most of the projects in AI ASIC started by the start-ups and system companies, the chipset development could take longer than expected if the spec is change or the performance doesn't meet the requirement, risking the timing of revenue recognition for NRE milestone. For the turnkey business, the timing of the production ramp and volume demand change could also impact the IC design service companies' revenue expectation.

- **Customers shift to foundry direct business model.** The IC design service companies charge their customers based on the design milestone thy reach in the NRE stage and a mark-up margin for the mass production stage. For smaller players who lack of scale and semiconductor knowledge and supply chain relationship, it is important for them to work with the IC design service companies with long-term track record working on different projects and strong supply chain management. However, if the customers' scale gets bigger and have stronger design capability, they could choose to work with foundries directly to avoid the charge from IC design service companies. The most noticeable case in the recent years is the cryptocurrency mining chipset, with Bitmain and Canaan negotiating with TSMC on the capacity support as their scale gets bigger.

  We would note the risk is lower for IC design service companies to lose their AI ASIC customers as the size of the each project and the IC design team in the start-ups and system houses is usually smaller, with the chipsets only for customised and more niche applications (vs cryptocurrency mining ASIC widely adopted in the mining activity in large scale) so they would still need support from IC design service companies. We believe foundries also prefer to work with IC design service companies for the smaller start-ups and system houses as it allows them to plan capacity in the advanced nodes more easily after experiencing the volatility in cryptocurrency chipset demand in 2017-18. Examples include Cambricon, an AI chipset start-up in China who has filed for IPO in the China A-share market, still working with Broadcom, while Brainchip, focusing on neuromorphic SoC and already listed in Australia, still working with Socionext in Japan on the back-end design.

- **Intensifying competition from Verisilicon in China.** As we have highlighted in this report's industry section, we believe Verisilicon, who plans to IPO in the STAR market, could be the key competition in the China domestic market for its peers overseas. However, with its technology and product mix mostly focusing on the consumer and edge IoT projects, we believe it could be more a threat for Faraday, while GUC and Alchip, with their higher HPC exposure, should see a milder impact in the next few years. Although Versilicon also targets to build a platform to support more advanced customers in China, we believe it will take time, while its foundry support, mostly from SMIC, GobalFoundries, and Samsung, may not be as attractive compared with GUC and Alchip's support from TSMC for the customers requiring advanced node support.

GUC's financials

Figure 182: GUC's income statement summary

Summary Income Statement	1Q20E	2Q20E	3Q20E	4Q20E	1Q21E	2Q21E	3Q21E	4Q21E	2015	2016	2017	2018	2019F	2020F	2021F	2022F
Net Sales	**3,170**	**2,927**	**3,301**	**3,641**	**3,667**	**3,705**	**4,218**	**4,185**	**7,762**	**9,290**	**12,161**	**13,460**	**10,710**	**13,039**	**15,775**	**17,716**
Sequential Change	*-3.8%*	*-7.7%*	*12.8%*	*10.3%*	*0.7%*	*1.0%*	*13.8%*	*-0.8%*								
Y/Y Change	*23.8%*	*20.6%*	*36.1%*	*10.4%*	*15.7%*	*26.6%*	*27.8%*	*14.9%*	*11.6%*	*19.7%*	*30.9%*	*10.7%*	*-20.4%*	*21.7%*	*21.0%*	*12.3%*
Cost of Goods Sold	2,405	2,189	2,378	2,570	2,570	2,598	2,962	2,911	5,568	6,901	8,996	9,443	7,180	9,543	11,040	12,274
Gross Profits	**765**	**737**	**923**	**1,071**	**1,098**	**1,108**	**1,256**	**1,274**	**2,194**	**2,390**	**3,165**	**4,017**	**3,530**	**3,496**	**4,735**	**5,442**
Gross Margin	***24.1%***	***25.2%***	***28.0%***	***29.4%***	***29.9%***	***29.9%***	***29.8%***	***30.4%***	***28.3%***	***25.7%***	***26.0%***	***29.8%***	***33.0%***	***26.8%***	***30.0%***	***30.7%***
Operating Exp. Promotion	68	67	75	80	80	80	89	87	295	358	324	309	284	290	335	365
% of Sales	*2.2%*	*2.3%*	*2.3%*	*2.2%*	*2.2%*	*2.2%*	*2.1%*	*2.1%*	*3.8%*	*3.8%*	*2.7%*	*2.3%*	*2.7%*	*2.2%*	*2.1%*	*2.1%*
Operating Exp. Administrative	61	59	66	71	70	70	78	74	212	214	282	338	329	256	293	312
% of Sales	*1.9%*	*2.0%*	*2.0%*	*1.9%*	*1.9%*	*1.9%*	*1.9%*	*1.8%*	*2.7%*	*2.3%*	*2.3%*	*2.5%*	*3.1%*	*2.0%*	*1.9%*	*1.8%*
Operating Expense R&D	562	556	623	672	667	669	746	709	1,125	1,196	1,628	2,274	2,220	2,413	2,791	2,974
% of Sales	*17.7%*	*19.0%*	*18.9%*	*18.5%*	*18.2%*	*18.1%*	*17.7%*	*16.9%*	*14.5%*	*12.9%*	*13.4%*	*16.9%*	*20.7%*	*18.5%*	*17.7%*	*16.8%*
Total Operating Exp	691	682	764	822	817	819	913	870	1,632	1,767	2,234	2,921	2,833	2,959	3,419	3,651
Income from Operations	**74**	**55**	**159**	**249**	**281**	**289**	**342**	**404**	**562**	**623**	**931**	**1,096**	**697**	**537**	**1,316**	**1,791**
% of Sales	***2.3%***	***1.9%***	***4.8%***	***6.8%***	***7.7%***	***7.8%***	***8.1%***	***9.7%***	***7.2%***	***6.7%***	***7.7%***	***8.1%***	***6.5%***	***4.1%***	***8.3%***	***10.1%***
Depreciation	86	86	86	86	86	86	86	86	73	78	90	187	345	343	343	343
Amortization	62	63	64	64	64	63	63	63	151	159	166	226	253	252	254	254
EBITDA	**222**	**204**	**308**	**398**	**430**	**438**	**491**	**553**	**787**	**860**	**1,187**	**1,510**	**1,295**	**1,132**	**1,913**	**2,388**
% of Sales	*7.0%*	*7.0%*	*9.3%*	*10.9%*	*11.7%*	*11.8%*	*11.7%*	*13.2%*	*10.1%*	*9.3%*	*9.8%*	*11.2%*	*12.1%*	*8.7%*	*12.1%*	*13.5%*
Non Operating Income	56	-	32	35	24	30	24	29	20	11	58	39	86	124	107	111
Net Investment Income/ (Loss)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pretax Income	**130**	**55**	**191**	**284**	**305**	**318**	**367**	**433**	**582**	**634**	**989**	**1,135**	**783**	**661**	**1,423**	**1,902**
% of Sales	*4.1%*	*1.9%*	*5.8%*	*7.8%*	*8.3%*	*8.6%*	*8.7%*	*10.4%*	*7.5%*	*6.8%*	*8.1%*	*8.4%*	*7.3%*	*5.1%*	*9.0%*	*10.7%*
Income Taxes Exp. /(Gains)	31	18	36	38	58	60	70	82	88	83	134	147	150	124	270	361
Tax Rate	*23.8%*	*33.2%*	*19.0%*	*13.5%*	*19.0%*	*19.0%*	*19.0%*	*19.0%*	*15.1%*	*13.1%*	*13.5%*	*13.0%*	*19.1%*	*18.8%*	*19.0%*	*19.0%*
Net Income before Extraordinaries	**99**	**37**	**155**	**246**	**247**	**258**	**297**	**351**	**494**	**551**	**855**	**988**	**633**	**537**	**1,153**	**1,541**
Minority Interest	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**(0)**	**0**	**(0)**	**(0)**	**0**	**0**	**0**	**0**
Extraordinaries	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Income after Extraordinaries	**99**	**37**	**155**	**246**	**247**	**258**	**297**	**351**	**494**	**551**	**855**	**988**	**633**	**537**	**1,153**	**1,541**
% of Sales	*3.1%*	*1.3%*	*4.7%*	*6.7%*	*6.7%*	*7.0%*	*7.0%*	*8.4%*	*6.4%*	*5.9%*	*7.0%*	*7.3%*	*5.9%*	*4.1%*	*7.3%*	*8.7%*
Preferred dividends	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Income after Preferred Dividends	**99**	**37**	**155**	**246**	**247**	**258**	**297**	**351**	**494**	**551**	**855**	**988**	**633**	**537**	**1,153**	**1,541**
Dividend to Common Share Holders	-	-	475	-	-	-	402	-	402	402	469	704	814	475	402	865
Retained Earnings	***99***	***37***	***(320)***	***246***	***247***	***258***	***(105)***	***351***	***92***	***149***	***386***	***284***	***(181)***	***61***	***751***	***676***
% of Sales	*3.1%*	*1.3%*	*-9.7%*	*6.7%*	*6.7%*	*7.0%*	*-2.5%*	*8.4%*	*1.2%*	*1.6%*	*3.2%*	*2.1%*	*-1.7%*	*0.5%*	*4.8%*	*3.8%*
GAAP EPS (NT$)	**0.74**	**0.27**	**1.16**	**1.83**	**1.84**	**1.92**	**2.22**	**2.62**	**3.69**	**4.11**	**6.38**	**7.37**	**4.73**	**4.00**	**8.60**	**11.50**
Pro Forma EPS (NT$)	**0.74**	**0.27**	**1.16**	**1.83**	**1.84**	**1.92**	**2.22**	**2.62**	**3.69**	**4.11**	**6.38**	**7.37**	**4.73**	**4.00**	**8.60**	**11.50**
Share Count (actual)	134	134	134	134	134	134	134	134	134	134	134	134	134	134	134	134
Share Count (weighted)	134	134	134	134	134	134	134	134	134	134	134	134	134	134	134	134

Source: Company data, Credit Suisse estimates

Figure 183: GUC's balance sheet summary

NT$ mn	1Q20E	2Q20E	3Q20E	4Q20E	1Q21E	2Q21E	3Q21E	4Q21E	2015	2016	2017	2018	2019	2020	2021	2022
Cash, Cash Equivalent	2,777	2,663	2,173	2,247	2,331	2,423	2,134	2,325	3,153	3,951	5,090	3,906	2,542	2,247	2,325	2,329
Inventories	2,108	1,920	2,085	2,253	2,253	2,277	2,597	2,552	736	728	1,153	1,332	2,103	2,253	2,552	2,850
Account receivables	1,364	1,259	1,420	1,566	1,578	1,594	1,814	1,800	636	785	917	910	1,418	1,566	1,800	2,030
Other current assets	531	490	553	610	615	621	707	701	275	335	265	480	553	610	701	791
Total current asset	**6,780**	**6,332**	**6,231**	**6,677**	**6,776**	**6,916**	**7,252**	**7,379**	**4,800**	**5,797**	**7,425**	**6,629**	**6,616**	**6,677**	**7,379**	**7,999**
LT investment	-	-	-	-	-	-	-	-	16	-	-	-	-	-	-	-
Fixed Assets	1,147	1,311	1,475	1,639	1,804	1,968	2,132	2,296	357	385	473	1,089	982	1,639	2,296	2,953
Intangible Assets	412	412	412	412	412	412	412	412	155	266	324	288	412	412	412	412
Other Assets	330	330	330	330	330	330	330	330	73	66	74	104	330	330	330	330
Total Non-Current Assets	**1,889**	**2,053**	**2,217**	**2,382**	**2,546**	**2,710**	**2,874**	**3,039**	**602**	**717**	**870**	**1,481**	**1,725**	**2,382**	**3,039**	**3,696**
Total assets	**8,669**	**8,385**	**8,449**	**9,058**	**9,322**	**9,626**	**10,127**	**10,418**	**5,402**	**6,515**	**8,295**	**8,109**	**8,341**	**9,058**	**10,418**	**11,695**
Accounts payable	1,845	1,680	1,824	1,971	1,971	1,993	2,272	2,233	556	1,373	1,626	1,228	1,535	1,971	2,233	2,493
ST interest bearing Liabilities	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other current liabilities	2,023	1,867	2,106	2,323	2,340	2,364	2,691	2,670	1,260	1,354	2,520	2,407	2,104	2,323	2,670	3,011
Total current liabilities	**3,868**	**3,547**	**3,931**	**4,295**	**4,311**	**4,357**	**4,963**	**4,903**	**1,816**	**2,728**	**4,146**	**3,635**	**3,638**	**4,295**	**4,903**	**5,504**
LT liabilities	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other LT liabilities	390	390	390	390	390	390	390	390	58	114	102	108	390	390	390	390
Total Long Term liabilities	**390**	**390**	**390**	**390**	**390**	**390**	**390**	**390**	**58**	**114**	**102**	**108**	**390**	**390**	**390**	**390**
Total Liabilities	**4,257**	**3,937**	**4,320**	**4,684**	**4,701**	**4,746**	**5,353**	**5,293**	**1,874**	**2,842**	**4,248**	**3,743**	**4,028**	**4,684**	**5,293**	**5,894**
Share Capital	1,340	1,340	1,340	1,340	1,340	1,340	1,340	1,340	1,340	1,340	1,340	1,340	1,340	1,340	1,340	1,340
Share Premium & Other Reserves	795	795	795	795	795	795	795	795	504	553	611	696	795	795	795	795
Retained earnings	2,297	2,334	2,014	2,260	2,507	2,765	2,659	3,010	1,681	1,781	2,107	2,338	2,198	2,260	3,010	3,686
Preferred Stocks	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-
Treasury Stock	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-
Other Equity	-21	-21	-21	-21	-21	-21	-21	-21	3	(2)	(11)	(9)	(21)	(21)	(21)	(21)
Total Equity	**4,412**	**4,449**	**4,129**	**4,374**	**4,622**	**4,879**	**4,774**	**5,125**	**3,528**	**3,672**	**4,047**	**4,366**	**4,313**	**4,374**	**5,125**	**5,801**
Minority Interest	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Total Liabilities & Equity	**8,669**	**8,385**	**8,449**	**9,058**	**9,322**	**9,626**	**10,127**	**10,418**	**5,402**	**6,515**	**8,295**	**8,109**	**8,341**	**9,058**	**10,418**	**11,695**

Source: Company data, Credit Suisse estimates

Figure 184: GUC's profitability ratios

NT$ mn	1Q20E	2Q20E	3Q20E	4Q20E	1Q21E	2Q21E	3Q21E	4Q21E	2015	2016	2017	2018	2019	2020	2021	2022
Return on Equity (ROE)	2.2%	0.8%	3.8%	5.6%	5.3%	5.3%	6.2%	6.8%	14.0%	15.0%	21.1%	22.6%	14.7%	12.3%	22.5%	26.6%
Return on Assets (ROA)	1.1%	0.4%	1.8%	2.7%	2.7%	2.7%	2.9%	3.4%	9.1%	8.5%	10.3%	12.2%	7.6%	5.9%	11.1%	13.2%
Return on Net Assets (RONA)	1.7%	0.6%	2.5%	3.6%	3.5%	3.6%	3.7%	4.3%	22.1%	21.5%	26.7%	23.5%	10.9%	7.9%	14.2%	16.5%
Return on invested capital									14.3%	15.4%	20.7%	22.3%	14.2%	11.2%	22.6%	26.7%
Return on Sales	3.1%	1.3%	4.7%	6.7%	6.7%	7.0%	7.0%	8.4%	6.4%	5.9%	7.0%	7.3%	5.9%	4.1%	7.3%	8.7%
Efficiency Ratios																
Asset Turns	1.5	1.4	1.6	1.6	1.6	1.5	1.7	1.6	1.4	1.4	1.5	1.7	1.3	1.4	1.5	1.5
Receivables turns (annualized)	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	12.2	11.8	13.3	14.8	7.6	8.3	8.8	8.7
Days sales outstanding (DSO)	39.3	39.3	39.3	39.3	39.3	39.3	39.3	39.3	29.9	30.8	27.5	24.7	48.3	43.8	41.7	41.8
Inventory turnover (annualized)	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	7.6	9.5	7.8	7.1	3.4	4.2	4.3	4.3
Days of inventory	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	48.3	38.5	46.8	51.5	106.9	86.2	84.4	84.7
Payables turnover (annualized)	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	10.0	5.0	5.5	7.7	4.7	4.8	4.9	4.9
Days of Payables	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	36.4	72.6	66.0	47.5	78.0	75.4	73.8	74.2
Cash conversion cycle	49.3	49.3	49.3	49.3	49.3	49.3	49.3	49.3	41.7	-3.3	8.3	28.7	77.3	54.6	52.2	52.4
Working Capital	$136	$122	$128	$135	$134	$135	$155	$150	-$169	-$881	-$1,811	-$912	$436	$135	$150	$166
(Increase)/Decrease in working capital	300	14	(6)	(7)	1	(2)	(19)	4	179	712	930	(899)	(1,348)	301	(15)	(16)
Per Share Values																
Book Value per common share	$32.92	$33.20	$30.81	$32.64	$34.49	$36.41	$35.62	$38.24	$26.32	$27.40	$30.20	$32.58	$32.18	$32.64	$38.24	$43.29
Tangible Book Value per common share																
Cash per common share	$20.72	$19.87	$16.22	$16.77	$17.40	$18.08	$15.93	$17.35	$23.65	$29.48	$37.98	$29.15	$18.97	$16.77	$17.35	$17.38
Net Cash per common share	$20.72	$19.87	$16.22	$16.77	$17.40	$18.08	$15.93	$17.35	$23.65	$29.48	$37.98	$29.15	$18.97	$16.77	$17.35	$17.38

Source: Company data, Credit Suisse estimates

Figure 185: GUC's cash flow summary

(NT$ mn)	1Q20E	2Q20E	3Q20E	4Q20E	1Q21E	2Q21E	3Q21E	4Q21E	2015	2016	2017	2018	2019	2020	2021	2022
Net income	**99**	**37**	**155**	**246**	**247**	**258**	**297**	**351**	**494**	**551**	**855**	**988**	**633**	**537**	**1,153**	**1,541**
Depreciation & Amortization	148	149	149	149	149	149	149	149	225	237	256	413	598	595	597	597
Dec (inc)-A/R	55	105	(161)	(146)	(11)	(16)	(220)	14	(103)	(149)	(133)	7	(508)	(148)	(234)	(230)
Dec (inc)-Inventory	(5)	189	(165)	(168)	0	(25)	(320)	45	(27)	9	(425)	(179)	(772)	(150)	(299)	(298)
Inc (Dec)-A/P	310	(165)	145	147	(0)	22	280	(39)	88	818	253	(398)	307	437	261	261
LT investment loss (gain)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Investment disposal loss (gain)	-	-	-	-	-	-	-	-	(5)	14	(1)	(1)	(1)	-	-	-
Others	(60)	(114)	176	160	12	18	241	(15)	262	(71)	1,123	(602)	(150)	162	256	251
Operating Cash Flow	**547**	**199**	**299**	**388**	**398**	**405**	**427**	**505**	**934**	**1,408**	**1,928**	**227**	**108**	**1,433**	**1,734**	**2,122**
Sale(Pur) of ST Inv.									5	2	1	1	1	-	-	-
Sale(Pur) of LT Inv.									(16)	-	-	-	-	-	-	-
Sale of FA									-	8	4	3	-	-	-	-
Capital Spending	**(250)**	**(250)**	**(250)**	**(250)**	**(250)**	**(250)**	**(250)**	**(250)**	**(78)**	**(69)**	**(143)**	**(529)**	**(490)**	**(1,000)**	**(1,000)**	**(1,000)**
Others	(62)	(63)	(64)	(64)	(64)	(63)	(63)	(63)	(130)	(145)	(176)	(219)	(246)	(252)	(254)	(254)
Investing Cash Flow	**(312)**	**(313)**	**(314)**	**(314)**	**(314)**	**(313)**	**(313)**	**(313)**	**(219)**	**(205)**	**(313)**	**(743)**	**(735)**	**(1,252)**	**(1,254)**	**(1,254)**
Inc (Dec) of Debt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bonds Issued (Redeemed)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Treasury Stock Dec(Inc)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proceed from new issue	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dividend paid	-	-	(475)	-	-	-	(402)	-	(402)	(402)	(469)	(670)	(670)	(475)	(402)	(865)
Others	0	(0)	(0)	-	(0)	0	-	0	(15)	-	3	0	(57)	0	0	-
Financing Cash Flow	**0**	**(0)**	**(475)**	**-**	**(0)**	**0**	**(402)**	**0**	**(417)**	**(402)**	**(466)**	**(670)**	**(727)**	**(475)**	**(402)**	**(865)**
Exchange influence									3	(4)	(9)	2	(11)	-	-	-
Change in Cash Flow	**235**	**(114)**	**(490)**	**74**	**84**	**92**	**(289)**	**191**	**300**	**797**	**1,140**	**(1,184)**	**(1,365)**	**(294)**	**78**	**3**
Cash equivalent - beginning	2,542	2,777	2,663	2,173	2,247	2,331	2,423	2,134	2,853	3,208	3,001	2,846	3,153	3,379	3,289	3,083
Cash equivalent - end	2,777	2,663	2,173	2,247	2,331	2,423	2,134	2,325	3,153	3,951	5,090	4,737	2,542	2,777	2,325	2,515
Operating cash per share	**$4.08**	**$1.49**	**$2.23**	**$2.89**	**$2.97**	**$3.02**	**$3.18**	**$3.76**	**$6.97**	**$10.51**	**$14.38**	**$1.69**	**$0.81**	**$10.69**	**$12.94**	**$15.83**
FCF per share	**$2.22**	**-$0.38**	**$0.36**	**$1.03**	**$1.10**	**$1.16**	**$1.32**	**$1.90**	**$6.39**	**$9.99**	**$13.32**	**-$2.25**	**-$2.85**	**$3.23**	**$5.48**	**$8.37**

Source: Company data, Credit Suisse estimates

Companies Mentioned *(Price as of 17-Jul-2020)*

ASE Industrial Holdings (3711.TW, NT$69.3)
Advanced Micro Devices, Inc. (AMD.OQ, $54.92)
Alchip Tech (3661.TW, NT$480.0, OUTPERFORM[V], TP NT$630.0)
Apple Inc (AAPL.OQ, $386.09)
Broadcom Ltd (AVGO.OQ, $311.34)
Cadence Design System (CDNS.OQ, $98.68)
Egis Technology Inc. (6462.TWO, NT$196.5)
Elan Microelectronics Corp (2458.TW, NT$139.5)
Faraday Technology Corporation (3035.TW, NT$48.95)
GUC (3443.TW, NT$284.0, NEUTRAL[V], TP NT$250.0)
Gigadevice (603986.SS, Rmb232.9)
Goodix (603160.SS, Rmb210.26)
Hua Hong Semiconductor Limited (1347.HK, HK$27.35)
Intel Corp. (INTC.OQ, $59.14)
Lenovo Group Ltd (0992.HK, HK$4.55)
Maxscend (300782.SZ, Rmb465.3)
MediaTek Inc. (2454.TW, NT$607.0)
Montage Tech (688008.SS, Rmb96.85)
NVIDIA Corporation (NVDA.OQ, $405.39)
NavInfo (002405.SZ, Rmb18.5)
Novatek Microelectronics Corp Ltd (3034.TW, NT$262.0)
Parade Technologies (4966.TWO, NT$1075.0)
QUALCOMM Inc. (QCOM.OQ, $91.2)
Realtek Semiconductor (2379.TW, NT$342.5)
SG Micro (300661.SZ, Rmb335.17)
Samsung Electronics (005930.KS, W54,400)
Semiconductor Manufacturing International Corp. (0981.HK, HK$29.0)
Silergy (6415.TW, NT$1735.0)
Synopsys Inc. (SNPS.OQ, $193.22)
Taiwan Semiconductor Manufacturing (2330.TW, NT$367.0, NEUTRAL, TP NT$365.0)
United Microelectronics (2303.TW, NT$16.4)
WINGTECH (600745.SS, Rmb133.71)
Will Semi (603501.SS, Rmb218.43)
Xilinx (XLNX.OQ, $99.17)
eMemory (3529.TWO, NT$466.0)

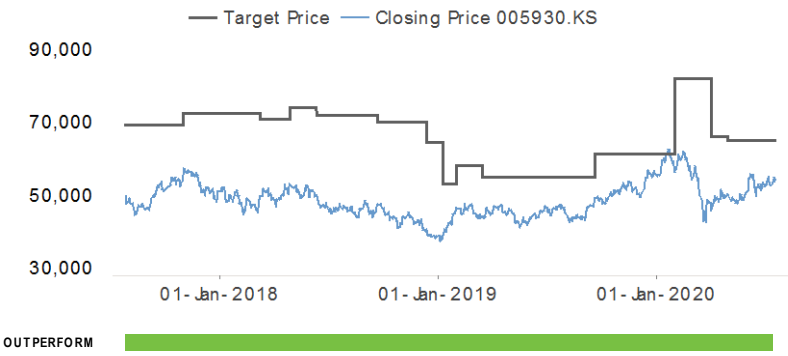
Disclosure Appendix

Analyst Certification

Haas Liu and Randy Abrams, CFA, each certify, with respect to the companies or securities that the individual analyzes, that (1) the views expressed in this report accurately reflect his or her personal views about all of the subject companies and securities and (2) no part of his or her compensation was, is or will be directly or indirectly related to the specific recommendations or views expressed in this report.

3-Year Price and Rating History for Samsung Electronics (005930.KS)

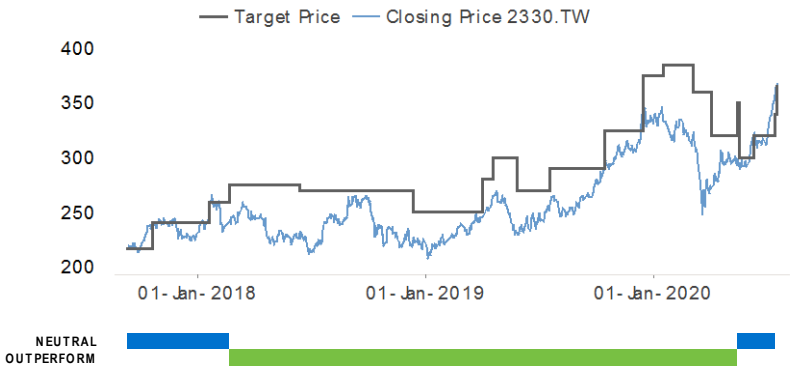
005930.KS	Closing Price	Target Price	
Date	(W)	(W)	Rating
27-Jul-17	49,800	69,200	O
31-Oct-17	55,080	72,400	
09-Mar-18	49,740	70,800	
27-Apr-18	53,000	74,000	
11-Jun-18	49,900	72,000	
21-Sep-18	47,400	70,000	
13-Dec-18	40,000	64,500	
08-Jan-19	38,100	53,000	
31-Jan-19	46,150	58,000	
15-Mar-19	44,200	54,800	
19-Sep-19	49,150	61,300	
31-Jan-20	56,400	82,000	
02-Apr-20	46,800	66,000	
29-Apr-20	50,000	65,000	



** Asterisk signifies initiation or assumption of coverage.*

3-Year Price and Rating History for Taiwan Semiconductor Manufacturing (2330.TW)

2330.TW Date	Closing Price (NT$)	Target Price (NT$)	Rating
10-Sep-17	218.00	217.00	N
20-Oct-17	237.50	241.00	
19-Jan-18	255.50	259.00	
20-Feb-18	236.50	275.00	O
12-Jun-18	229.00	270.00	
12-Dec-18	226.50	250.00	
01-Apr-19	245.50	280.00	
19-Apr-19	264.50	300.00	
27-May-19	231.00	270.00	
19-Jul-19	259.00	290.00	
14-Oct-19	290.00	325.00	
16-Dec-19	336.00	375.00	
17-Jan-20	333.00	385.00	
04-Mar-20	320.50	360.00	
02-Apr-20	271.50	320.00	
15-May-20	298.00	350.00	
18-May-20	290.00	300.00	N
09-Jun-20	319.00	320.00	
13-Jul-20	354.50	340.00	
17-Jul-20	367.00	365.00	



** Asterisk signifies initiation or assumption of coverage.*

As of December 10, 2012 Analysts' stock rating are defined as follows:

Outperform (O) : The stock's total return is expected to outperform the relevant benchmark* over the next 12 months.

Neutral (N) : The stock's total return is expected to be in line with the relevant benchmark* over the next 12 months.

Underperform (U) : The stock's total return is expected to underperform the relevant benchmark* over the next 12 months.

**Relevant benchmark by region: As of 10th December 2012, Japanese ratings are based on a stock's total return relative to the analyst's coverage universe which consists of all companies covered by the analyst within the relevant sector, with Outperforms representing the most attractive, Neutrals the less attractive, and Underperforms the least attractive investment opportunities. As of 2nd October 2012, U.S. and Canadian as well as European (excluding Turkey) ratings are based on a stock's total return relative to the analyst's coverage universe which consists of all companies covered by the analyst within the relevant sector, with Outperforms representing the most attractive, Neutrals the less attractive, and Underperforms the least attractive investment opportunities. For Latin America, Turkey and Asia (excluding Japan and Australia), stock ratings are based on a stock's total return relative to the average total return of the relevant country or regional benchmark (India - S&P BSE Sensex Index); prior to 2nd October 2012 U.S. and Canadian ratings were based on (1) a stock's absolute total return potential to its current share price and (2) the relative attractiveness of a stock's total return potential within an analyst's coverage universe. For Australian and New Zealand stocks, the expected total return (ETR) calculation includes 12-month rolling dividend yield. An Outperform rating is assigned where an ETR is greater than or equal to 7.5%; Underperform where an ETR less than or equal to 5%. A Neutral may be assigned where the ETR is between -5% and 15%. The overlapping rating range allows analysts to assign a rating that puts ETR in the context of associated risks. Prior to 18 May 2015, ETR ranges for Outperform and Underperform ratings did not overlap with Neutral thresholds between 15% and 7.5%, which was in operation from 7 July 2011.*

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Overweight : The analyst's expectation for the sector's fundamentals and/or valuation is favorable over the next 12 months.

Market Weight : The analyst's expectation for the sector's fundamentals and/or valuation is neutral over the next 12 months.

Underweight : The analyst's expectation for the sector's fundamentals and/or valuation is cautious over the next 12 months.

**An analyst's coverage sector consists of all companies covered by the analyst within the relevant sector. An analyst may cover multiple sectors.*

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Global Ratings Distribution

Rating	Versus universe (%)	Of which banking clients (%)
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Neutral/Hold*	37%	(27% banking clients)
Underperform/Sell*	12%	(21% banking clients)
Restricted	1%	

**For purposes of the NYSE and FINRA ratings distribution disclosure requirements, our stock ratings of Outperform, Neutral, and Underperform most closely correspond to Buy, Hold, and Sell, respectively; however, the meanings are not the same, as our stock ratings are determined on a relative basis. (Please refer to definitions above.) An investor's decision to buy or sell a security should be based on investment objectives, current holdings, and other individual factors.*

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The analyst(s) responsible for preparing this research report received compensation that is based upon various factors including Credit Suisse's total revenues, a portion of which are generated by Credit Suisse's investment banking activities

Target Price and Rating
Valuation Methodology and Risks: (12 months) for Alchip Tech (3661.TW)

Method: Our OUTPERFORM rating and target price of NT$630 for Alchip Tech is based on 30x P/E (price-to-earnings), factoring in our expectation for 30% sales CAGR from 2019-22, implying 20% upside from the current price of NT$522. We believe the upper half of the long-term valuation should be supported by the company's earnings upside from stronger-than-expected China PC CPU replacement demand and faster-than-expected Phytium's server CPU penetration into the China government and SOE projects.

Risk: Risk to our OUTPERFORM rating and target price of NT$630 for Alchip Tech include: (1) Macro uncertainty leads to slower semiconductor investment, (2) Timing uncertainty in AI chipset development, (3) Customers shift to foundry direct business model, (4) Slower local CPU penetration in China, (5) U.S. further expands its ban on China companies' access to IP/EDA tools.

Target Price and Rating
Valuation Methodology and Risks: (12 months) for GUC (3443.TW)

Method: Our NEUTRAL rating and target price of NT$250 for GUC is based on 28x P/E (price-to-earnings). We believe the company's share is fairly valued at the upper half of its historical range, factoring in its opportunity in 5G and AI, though the timing of the project ramp for meaningful revenue contribution and profitability remain uncertainty.

Risk: Risk to our NEUTRAL rating and target price of NT$250 for GUC include: (1) Macro uncertainty leads to slower semiconductor investment, (2) Timing uncertainty in AI chipset development, (3) Customers shift to foundry direct business model.

Target Price and Rating
Valuation Methodology and Risks: (12 months) for Taiwan Semiconductor Manufacturing (2330.TW)

Method: Our NT$365 target price for TSMC is based on 18.5x 2021E EPS (earnings per share), implying 3.2x P/B (price-to-book), near the midpoint of its average 11-15x and 2.5-3.5x range. We see its business outlook improving, and technology leadership should keep its market share and profitability intact; dividends will likely rise again as capex moderates. We therefore have an NEUTRAL rating on the stock.

Risk: Risks that could impede achievement of our NT$365 target price and NEUTRAL rating for TSMC would include: fierce competition, demand failing to pick up, or Apple orders not being as strong as expected.

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注：太多了，无法全部一一列出。。。

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